Supsd by FM 17-12 Nov. 1964

FM 17-12

DEPARTMENT OF THE ARMY FIELD MANUAL

TANK GUNNERY

HEADQUARTERS, DEPARTMENT OF THE ARMY

APRIL 1961

AGO 4950B

FIELD MANUAL

TANK GUNNERY

FM 17-12 }
CHANGES No. 1 }

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON 25, D.C., *3 May 1961*

FM 17-12, 5 April 1961, is changed as follows:

237. General

(Superseded)

The tank crewman preliminary gunnery examination is designed to assist the commander in determining whether his tank crewmen are sufficiently trained to perform the functions connected with firing the qualification tables. Accordingly, each member of the tank crew is required to perform tests number 1 through 16 satisfactorily within the time allotted before he is permitted to fire the subcaliber tables or participate as a member of a crew firing the tank crew gunnery qualification tables. An additional requirement is imposed on those crewmen assigned as tank commanders of tanks equipped with range finders by test number 17. Successful completion of this test is a prerequisite for a crewman to act as a tank commander during the tank crew gunnery qualification tables only. Failure of any part of a test means that the crewman fails the examination and, after any necessary training, must be reexamined on the test(s) he has failed. The examination is conducted under the direction of examiners who may be officers or noncommissioned officers. Results are recorded on an examination record (fig. 114).

252.1 Test on Placing Range Finder in Operation

(Added)

Note. This test is applicable only when the tanks of a unit are equipped with range finders.

a. Procedure. For this test a tank with an operable range finder is required. The crewman is required to demonstrate and explain the prescribed steps for placing the range finder in operation.

b. Examiner's Guide.

(1) Examiner: USING PROPER SEQUENCE, PLACE RANGE FINDER IN OPERATION. (Starts time.)
(2) Crewman: Places range finder in operation, announcing each step as it is performed. Announces COMPLETE.
(3) Examiner: Stops time.
(4) Time: 2 minutes.

UNIT ______________________ NAME __________________________

DATE ________________ GRADE ______________ SN ______________

TANK CREWMAN PRELIMINARY GUNNERY EXAMINATION RECORD

TEST NO.	TITLE	SAT	UNSAT	REMARKS***	EXAMINEE'S INITIALS
1	Field disassembly and assembly of breech mechanism				
2	Putting turret in power operation				
3	Use of replenisher indicator tape				
4	Identification and use of ammunition				
*5	Checking and adjusting firing mechanisms.				
6	Boresighting and zeroing the main gun				
7	Boresighting and zeroing the coaxial machinegun				
*8	Boresighting and zeroing the cupola-mounted machinegun.				
9	Direct laying and sensing adjustment				
10	Non-sensing method of adjustment				
11	Preparing and firing from a range Card				
*12	Adjusting head space on caliber .30 machinegun				
*13	Adjusting head space and timing and mounting on caliber .50 machinegun.				
14	Misfire procedure				
15	Safety and control measures				
*16	Placing range finder in operation				
**17	Determining range using range finder				

* Does not apply to all type tanks or applies only in part.

** Prerequisite for crew qualification tables. Required only for assigned tank commanders of applicable type tanks.

*** P – Procedure incorrect
T – Time limit exceeded
A – Accuracy not attained
X – Requires much more training

COMMENT: ______________________________________

QUALIFIED FOR FIRING:

	YES	NO	NOT REQUIRED
Crewman Courses			
Crew Courses			

____
OFFICER IN CHARGE

Figure 114. (Superseded) *Tank Crewman Preliminary Gunnery Examination Record.*

252.2 Test on Determining Range Using Range Finder

(Added)

Note. This test is a prerequisite for assigned tank commanders to participate in crew qualification firing. It is applicable only when the tanks of a unit are equipped with range finders. Individuals should be tested on the same tank used for previous range finder training.

a. Procedure. See paragraph 225 for procedure. For the purposes of this requirement, the crewman will not be permitted to observe the range scale of the range finder. A single target positioned at 2,000 meters (yards) will be used for determining operator proficiency. Operator will accomplish 20 rangings. The error of each ranging will be determined and recorded. A maximum average error of 100 meters (yards) will be allowed for qualification.

b. Examiner's Guide.

(1) Examiner: DETERMINE RANGE TO TARGET ________. INDICATE WHEN YOU HAVE COMPLETED EACH RANGING.

(2) Crewman: Indexes final TIC or ICS setting on range finder. Ranges on designated target and indicates when each ranging is complete. Repeats ranging for 20 readings.

(3) Examiner: Records each indexed range setting and determines amount of error.

(4) Time: No time limit.

BY ORDER OF THE SECRETARY OF THE ARMY:

G. H. DECKER,
General, United States Army,
Chief of Staff.

Official:

R. V. LEE,
Major General, United States Army,
The Adjutant General.

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NG: State AG (3); units—same as Active Army except allowance is two copies to each units.

USAR: Same as Active Army.

For explanation of abbreviations used, see AR 320-50.

U.S. GOVERNMENT PRINTING OFFICE: 1961

FIELD MANUAL No. 17–12

HEADQUARTERS, DEPARTMENT OF THE ARMY
WASHINGTON 25, D. C., *3 April 1961*

TANK GUNNERY

* This manual supersedes FM 17–12, 21 May 1957; chapter 4, FM 17–78, 15 April 1955, including those portions of C 1, 17 March 1958, that pertain to chapter 4; chapters 4 and 5, FM 17–79, 13 October 1955, including those portions of C 3, 25 August 1959, that pertain to chapters 4 and 5; chapters 5 and 6, FM 17–80, 30 January 1956, including C 2, 29 September 1959.

PART ONE
GENERAL

CHAPTER 1
INTRODUCTION

1. Purpose

This manual presents tank gunnery principles, methods, and techniques, and training exercises and proficiency tests applicable to all types and models of standard tanks. Elements of tank gunnery are treated in detail to promote uniformity and high standards of training and to provide a practical reference for all echelons of command. If the principles and techniques are properly applied, they will insure the most effective use of tank weapons, both in training and in combat.

2. Scope

a. This manual is divided into five parts. Part one outlines the purpose and scope of this manual. Part two presents general characteristics of tank armaments, turrets, armament controls, ammunition, and ballistics; part three, the fundamentals of tank gunnery and fire control equipment; part four, the conduct of fire, both direct and indirect; and part five, tank gunnery training, testing, and qualification, familiarization, and practice firing, and procedures for establishing and conducting tank firing ranges.

b. For detailed information on nomenclature, functioning, maintenance, operation, disassembly, assembly, and mounting of specific types of materiel, equipment, and weapons, refer to the appropriate technical manual.

c. Units equipped with nonstandard tanks may modify the methods of conduct of fire and firing exercises, when necessary, to conform with available equipment. When it is necessary to modify a qualification firing exercise, the number of rounds fired will not be changed and the modified exercise must be at least as challenging as the prescribed exercise.

d. The material presented herein is applicable without modification to both nuclear and nonnuclear warfare.

e. Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to US Army Armor School.

PART TWO
MATERIEL

CHAPTER 2
CHARACTERISTICS OF TANK ARMAMENT, TURRETS, AND ARMAMENT CONTROLS

Section I. INTRODUCTION

3. Background

All tanks are characterized by mobility, armor-protected firepower, and shock action. Mobility is the ability of the tank to negotiate various types of terrain and to move rapidly from place to place on the battlefield. How well a tank moves over the ground depends largely upon its power plant, its suspension system, and its crew. Armor-protected firepower is the ability of the tank to shoot rapidly and accurately in any direction, with a multiplicity of weapons, and, at the same time, furnish adequate armor protection for the crewmen. The speed and accuracy of fire depend upon the gun-ammunition combination, turret and gun controls, fire control system, and skill of the tank crew. Shock action is obtained by properly employing mobility and firepower.

4. Characteristics of Tanks

All standard tanks have the following in common:

a. The crewmen stationed in the turret (gun crew) include the tank commander, who determines range to targets, controls and, when necessary, adjusts the fire of all weapons, loads and fires the cupola-mounted or external turret-mounted machinegun (par. 9), and directs the actions of all crewmen; the gunner, who aims, fires, and adjusts the fire of the main gun and the coaxial machinegun; and a loader, who loads the main gun and coaxial machinegun.

b. The turret, mounted on the turret ring, can be rotated by the gunner, continuously and with variable speed in either direction, using manual or power control, or by the tank commander, using power control (on some tanks the tank commander's power control will override the gunner's power control). These controls permit firing in any direction without moving the tank, slow or rapid traverse, and immediate reversal of direction.

c. The main gun is mounted in a cradle that is mounted on trunnions in the forward part of the turret. The gun traverses with the turret, but as the gun elevates it moves independently of the turret. The gunner elevates the gun by use of manual or power elevation control, and the tank commander by use of his power elevation control.

d. The gun cradle includes a mechanism that limits the movement of the gun in recoil and returns the gun to the firing position after the weapon is fired.

e. The main gun is aimed primarily by use of direct-fire control systems, but may be laid also by use of auxiliary fire control instruments. Direct-fire sights are mounted for use by the gunner and tank commander; auxiliary fire control instruments for use by the gunner.

f. The main gun normally is fired by the gunner, but it can be fired also by the tank commander. It is provided with a safety to prevent accidental firing.

g. A machinegun is mounted coaxially with the main gun and it is aimed with the same fire control systems used for the main gun except that on some type tanks a separate sight is available for laying this gun.

h. A cupola-mounted or external turret-mounted machinegun is provided the tank commander for use against aerial and ground targets.

i. The turret can be locked in any position by means of a lock located inside the turret. A gun travel lock is located on the rear deck of the tank. These locks are designed to prevent damage to the traverse and elevation systems.

j. Ammunition for the main gun and machineguns is stowed so that some rounds are immediately available for loading. Other ammunition may be stowed in the turret overhang, in the sides of the hull, or in the forward part of the hull.

k. The rear of the turret overhangs the turret ring to balance the turret. The space provided by the turret overhang is used for the radios, a ventilator, ammunition stowage racks, and miscellaneous equipment.

Section II. MAIN ARMAMENT AND MOUNTS

5. General

Tank main guns vary in caliber but are fundamentally of the same design. They have the following characteristics:

a. Mounted in a combination gun mount.

b. Consist of three or four main parts or assemblies—tube, bore evacuator, breech mechanism, and, in some cases, a muzzle attachment.

c. Incorporate a breech that can be opened manually. The breech closes when the extractors are tripped. During firing, the breech opens on counterrecoil and ejects the empty cartridge case.

6. Combination Gun Mount

The combination gun mount consists of a gun shield and a cradle. The gun mount supports the main gun on trunnion bearings and provides attachments for the recoil mechanism, breech operating and firing mechanisms, the coaxial machinegun mount, the recoil guards, and the telescope mount.

7. Recoil Mechanisms

Recoil mechanisms are of the hydrospring, constant recoil distance type, designed to bring the gun to rest at the end of a predetermined recoil distance and to return the gun to the firing position with a minimum of shock.

8. Main Gun

The main gun, a high-velocity, flat-trajectory weapon, has a tube machined for attachment of the breech mechanism, bore evacuator, and, in some cases, a recoil piston and a muzzle attachment. Bore evacuators are mounted on the gun tube to withdraw the smoke and residual gases (that result from firing) through the muzzle end. On some types of tanks a muzzle attachment is provided to reduce the obscuration effect of smoke and gases when the gun is fired.

Section III. TANK MACHINEGUNS AND MOUNTS

9. General

All standard tanks are equipped with two machineguns, one mounted coaxially with and to the left of the main gun, the other mounted either in a cupola (cupola-mounted) or on the top exterior portion of the turret in front of the tank commander's hatch (externally turret-mounted).

10. Coaxial Machinegun

Either a 7.62-mm or a caliber .30 machinegun is mounted coaxially with the main gun. The coaxial machinegun can be fired electrically by the gunner or tank commander. The loader can fire this weapon manually, and in the event of a malfunction of the electrical circuit, he may be directed to do so by the gunner or tank commander. The controls are the same for manipulating the coaxial machinegun and the main gun, but it is not normally fired when the main gun is being used to engage a target. For boresighting and zeroing of the coaxial machinegun, see paragraphs 52*b* and 54*b*. For employment of the coaxial machinegun, see paragraphs 128 and 132.

11. Cupola-Mounted or External Turret-Mounted Machinegun

All standard tanks have a cupola-mounted or external turret-mounted caliber .50 machinegun. If this machinegun is cupola-mounted, it is fired electrically or manually; if turret-mounted, it is fired manually. Because of separate controls, both types can be moved independently of the main gun and can be fired at the same time as the main gun. For boresighting and zeroing of the cupola-mounted machinegun, see paragraphs 52*c* and 54*c*. For employment of the caliber .50 machinegun, see paragraphs 129 and 133.

12. Commander's Cupola

A rotatable commander's cupola is mounted on some types of tanks. The cupola provides a mount and controls for the caliber .50 machinegun, affords the tank commander armor protection while firing the machinegun, and increases the accuracy of fire of this weapon when engaging ground targets.

Section IV. MAINTENANCE OF TANK-MOUNTED WEAPONS

13. Maintenance of Tank-Mounted Weapons

Maintenance of tank guns includes preventive maintenance, cleaning, and inspection.

a. Maintenance. Appropriate publications prescribe the services to be performed, maintenance responsibilities, and maintenance allocation charts.

b. Cleaning. Before being cleaned, the gun tube should be cool enough to be touched with the bare hand. When cleaning, do not attempt to obtain a bright finish beyond absolute cleanliness. A properly cleaned bore is, normally, uniformly light gray in color.

c. Exercising the Recoil System. During periods when the gun is not being fired, the recoil system must be exercised at least once every 6 months. This exercise, performed by second-echelon or Ordnance personnel, inhibits the formation of rust on the unpainted portion of the gun tube and prevents oil seals from drying and cracking, thereby preventing damage to the recoil system when the gun is fired.

d. Inspection of Gun Tubes. Gun tubes may be condemned by Ordnance when it is determined (by inspection) that a gun tube is unsafe to fire or (by bore measurement) that it lacks firing accuracy.

(1) *Inspections.* Gun tubes are inspected by tank crews to insure proper maintenance and determine, to the maximum, the existence of damage (cracks, bulges, gouges, etc.) or unusual wear. Using units are not authorized to condemn gun tubes; but if any doubt exists as to the serviceability of a tube, Ordnance personnel will be notified and the gun will not be fired until inspected and declared serviceable by them. In addition to this inspection, Ordnance must be requested to conduct an inspection of gun tubes as follows:

(*a*) Within 90 days before the initial firing of a gun and within each 90-day interval that the gun is fired continuously or recurringly.

(*b*) Within 90 days before firing the gun at semiannual, annual, or other irregular periods.

(2) *Bore measurement.* Tube condemnation is based on bore measurement and inspection and not on the number of rounds fired. The measurement of a tube bore is performed by Ordnance. The using unit must request this measurement for each gun tube when the number of rounds fired equals the round limit (or is so close to this figure that it will affect completion of firing exercises) as entered in the weapon record book by Ordnance. In training, this round limit must not be exceeded. In combat, the urgency of the situation will determine whether the round limit is to be exceeded, and if it is the crew will conduct frequent inspections during firing, and have the bore measured thereafter as soon as practicable.

e. Weapon Record Book. For each tank main gun there is a weapon record book for recording of the number of rounds fired (by number, type (including blank rounds), and date), Ordnance inspections (including bore measurements), repairs made, items replaced, and other pertinent data. Unit commanders must insure that these books are properly maintained.

Section V. TANK-MOUNTED SEARCHLIGHTS

14. General

Some tanks in armor units are equipped with searchlights that are coaxially mounted with the main gun. Of these searchlights, some have only a visible light capability and some both visible light and infrared light. On tanks that do not have a stowage rack for the searchlight, the light remains affixed in its coaxial position. If the tank has a stowage rack, then the light is removed for daylight firing. With the removal of the light the gun can be manipulated somewhat more easily and is less vulnerable to enemy fire. In tank gunnery, a tank-mounted searchlight is used to illuminate targets at night. When infrared light is employed, the sighting devices used for firing must have an infrared light capability. For boresighting of the searchlight, see paragraph 52*d*. For employment of the searchlight, see paragraph 157*b*(6) and FM 17–1, appendix VI.

CHAPTER 3
TANK GUN AMMUNITION AND BALLISTICS

Section I. INTRODUCTION

15. General

The decision as to what type of ammunition is to be used against a target is based on the commander's knowledge of the capabilities of ammunition. The proper type of ammunition must be used to insure destruction of the target with a minimum of time and ammunition. For employment of standard types of ammunition, see paragraphs 97, 135, and 136.

16. Round of Ammunition

A round of ammunition comprises all of the components necessary to fire the weapon one time. For tank gun ammunition these components are the projectile (which may include a fuze), the propellant, the primer, and the cartridge case (fig. 1).

Caution. **Explosive ammunition, or components containing explosives, *must* be handled with care at all times. The explosive elements in primers and fuzes are particularly sensitive to shock and high temperatures. Prescribed precautions for handling ammunition are stated in paragraph 285 and TM 9-1903.**

17. Classification of Tank Gun Ammunition

Tank gun ammunition is either fixed or separated complete rounds. In fixed rounds, all components are firmly contained by the cartridge case. In separated rounds, the projectile is separated from the cartridge case and the primer and propellant are sealed in the cartridge case. Tank gun ammunition is classified as armor-defeating, antipersonnel or antimateriel, and chemical.

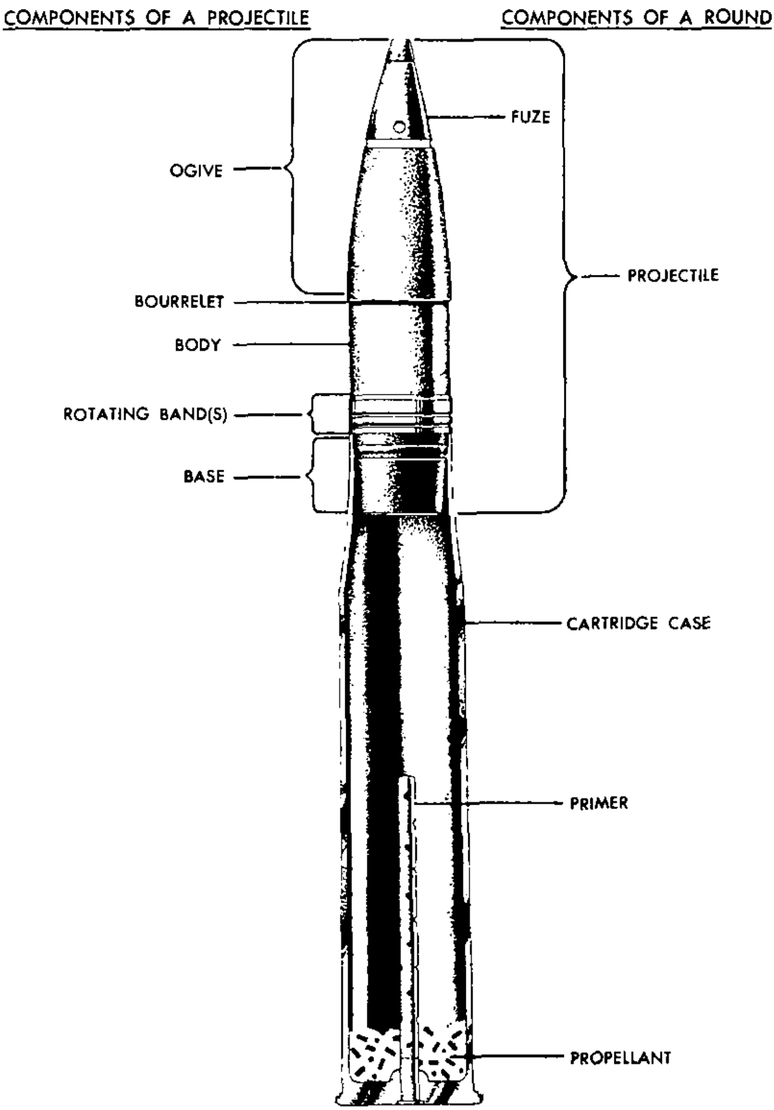


Figure 1. A round of tank gun ammunition.

Section II. PROJECTILES AND FUZES

18. General

Projectiles are classified as inert or filled. Inert projectiles contain no explosive filler and consist of metal slugs that obtain their destructive effect by mass and velocity (kinetic energy). Filled projectiles contain either an explosive or a chemical filler. Filled projectiles are fuzed to detonate the explosive or to disseminate the chemical. Some types of tank gun projectiles contain a tracer element in the base to enable crewmen to sense the round.

19. Projectile Nomenclature

The forward portion of the projectile, from the point to the bourrelet, is called the ogive (fig. 1). The ogive serves to streamline the projectile and provide better ballistic performance. As armor-defeating projectiles have a short radius of ogive, a windshield or false ogive is placed over the armor-piercing head, in some cases, to increase the ability to overcome air resistance and consequently increase its penetrating effect. In certain filled projectiles, the fuze is a part of the ogive. To the rear of the ogive is the bourrelet. The bourrelet is an accurately machined cylindrical surface, of diameter slightly larger than the body, and is designed to fit snugly in the gun bore. It forms the front bearing surface of the projectile and centers the projectile in the gun tube. The body is slightly smaller in diameter than the bourrelet and rotating bands and may contain a filler. Rotating bands are at the rear of the projectile and form the rear bearing surface, sealing the propelling gases behind the projectile and, in the case of a spin-stabilized projectile, imparting spin to the projectile as it moves forward in the gun tube. Rotating bands are made of a relatively soft material and are of sufficient diameter to engrave in the bore rifling as the projectile moves forward in the bore after firing. On spin-stabilized projectiles. the rotating band is rigidly attached to the body of the projectile and the rotation imparted to the rotating bands by the twist of the rifling causes the projectile to rotate or spin, providing stability in flight. On fin-stabilized projectiles, the rotating band does not impart rotation or spin to the projectile because it turns freely around the body of the projectile. Stability of the projectile in flight is provided by fins on the base of the projectile. The base is that part of the projectile upon which the expanding propelling gases act to force the projectile forward. The base also may contain a tracer element and base detonating fuze.

20. Armor-Defeating Projectiles

Armor-defeating projectiles achieve their effect by means of kinetic energy or chemical energy.

a. Kinetic energy projectiles depend upon their velocity and mass to penetrate armor protection (A, fig. 2). Kinetic energy projectiles include armor-piercing (shot), hypervelocity armor-piercing (hypershot), and hyper-velocity armor-piercing discarding sabot (sabot). Hypershot and sabot projectiles are lighter in weight than shot and are propelled at higher velocities. They incorporate a core of tungsten carbide, a metal of extremely high density and hardness.

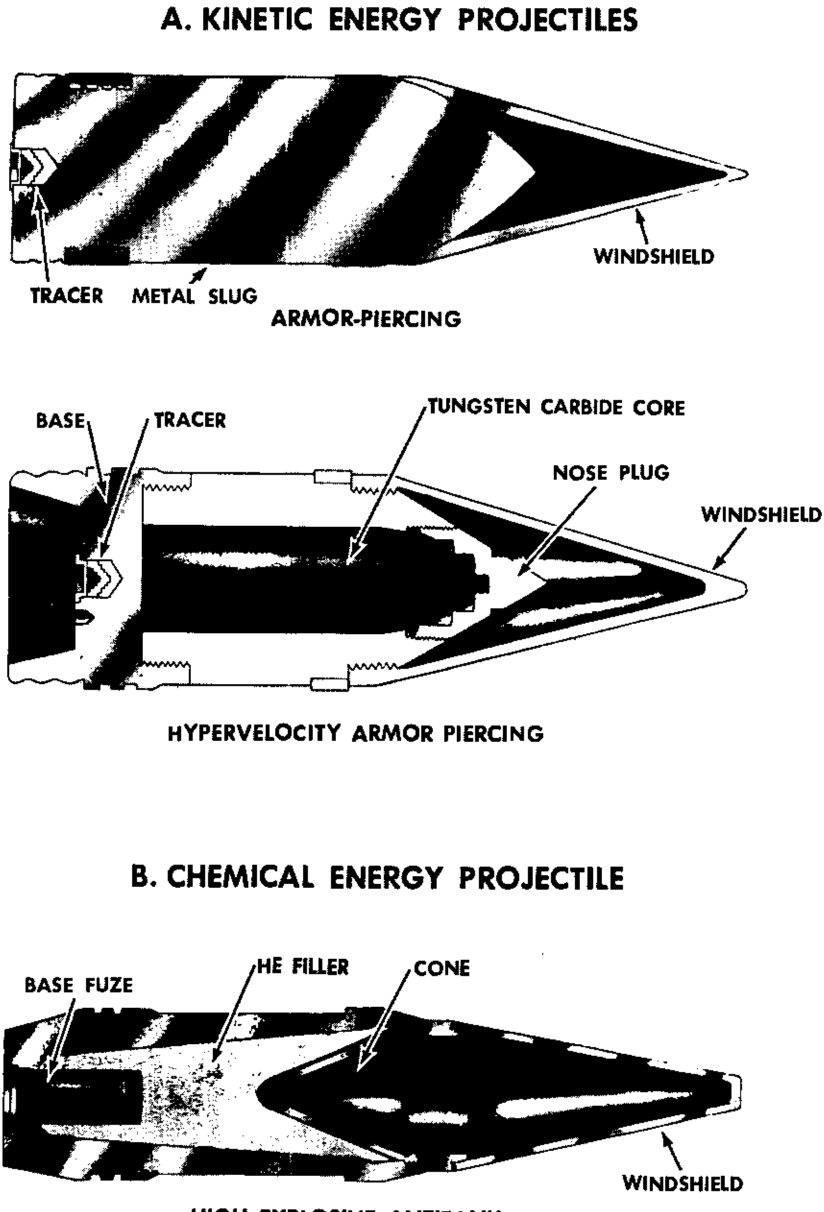


Figure 2. Armor-defeating projectiles.

b. Chemical energy projectiles (B, fig. 2) include high explosive antitank (HEAT) and high explosive plastic (HEP) (fig. 3). Each of these rounds is equipped with a base detonating fuze. Chemical energy projectiles have a given armor-defeating potential that is constant regardless of range to the target or velocity of the projectile.

(1) *HEAT.* Penetration by the HEAT projectile depends on the shaped charge principle. Detonation of the charge causes formation of a supervelocity gaseous jet that forces its way through armor of considerable thickness.

(2) *HEP.* Upon impact, the plastic explosive filler of a HEP projectile mushrooms on the armor and detonates. This force transmits shock waves through the armor, causing large jagged spall to be torn from the back of the armor plate.

21. Antipersonnel and Antimateriel Projectiles

There are three types of antipersonnel and antimateriel projectiles; high explosive (HE), high explosive plastic (HEP), and canister (fig. 3).

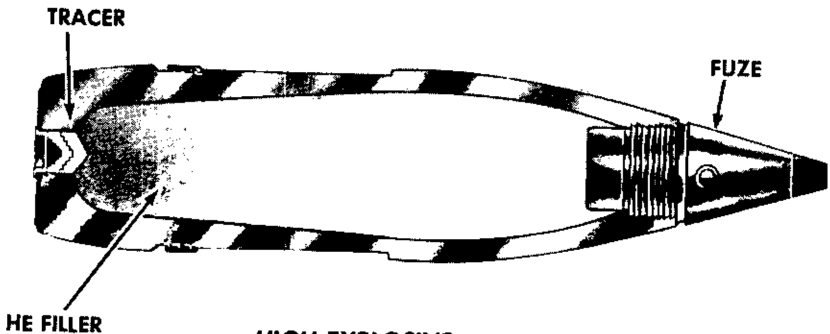
a. High explosive projectiles are filled and fuzed. They consist of a steel body filled with a high explosive such as TNT or composition B. The fuze is a point detonating type and detonates either on impact or as a result of a delay action. The fuze detonates the explosive filler, which causes fragmentation and blast in the area of impact or detonation.

b. High explosive plastic projectiles are also filled and fuzed (base-detonating) and cause fragmentation and blast in the area of impact or detonation.

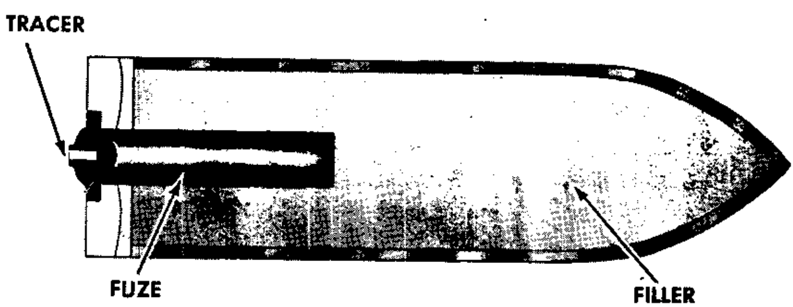
c. Canister projectiles are cylindrical in shape and contain a large number of small pieces of steel (subprojectiles). As the projectile leaves the muzzle of the gun, centrifugal force ruptures the canister and discharges the steel subprojectiles.

22. Chemical Projectiles

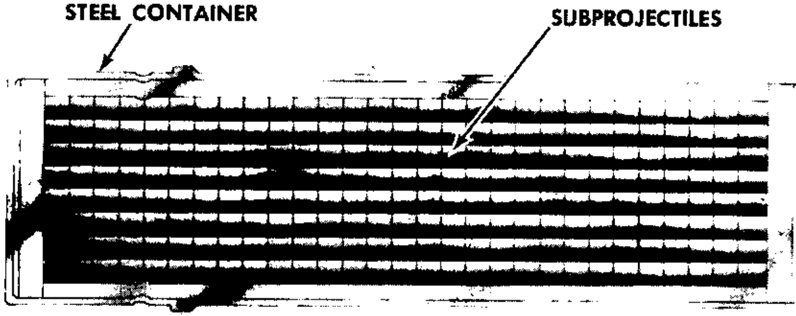
Although there are many types of chemical projectiles, usually only the white phosphorus projectile (smoke) (fig. 4) is fired from tanks. It is similar in construction to the high explosive projectile, but contains a filler of white phosphorus that ignites on contact with air. It has a point detonating fuze which, upon impact, initiates a burster charge causing the projectile body to rupture. The white phosphorus, when scattered and exposed to the air, burns and produces a white smoke. It has a point detonating fuze that detonates on impact or as a result of a delay action.



HIGH EXPLOSIVE



HIGH EXPLOSIVE PLASTIC



CANISTER

Figure 3. Antipersonnel and antimateriel projectiles.

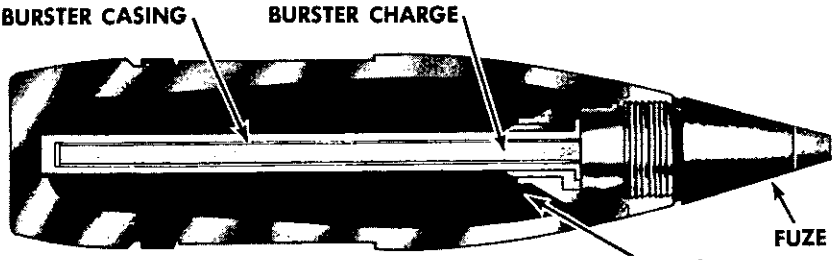


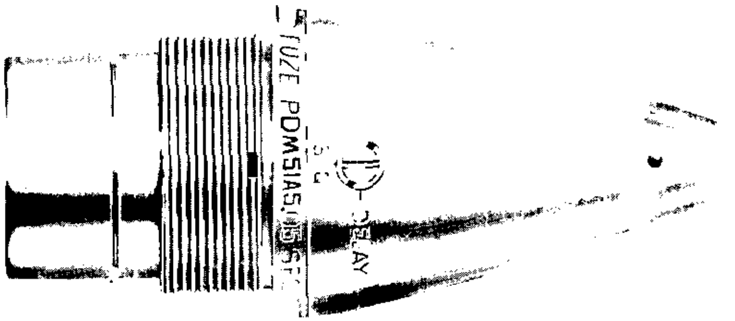
Figure 4. Chemical projectile.

23. Fuzes

Fuzes are attached to filled projectiles to initiate detonation or action of the filler. Fuzes are classified, according to their location on the projectile, as point detonating or base detonating (and point-initiating base detonating). They also are classified according to their method of functioning, as time, proximity, or impact. Impact fuzes are the only type used in tank gun ammunition.

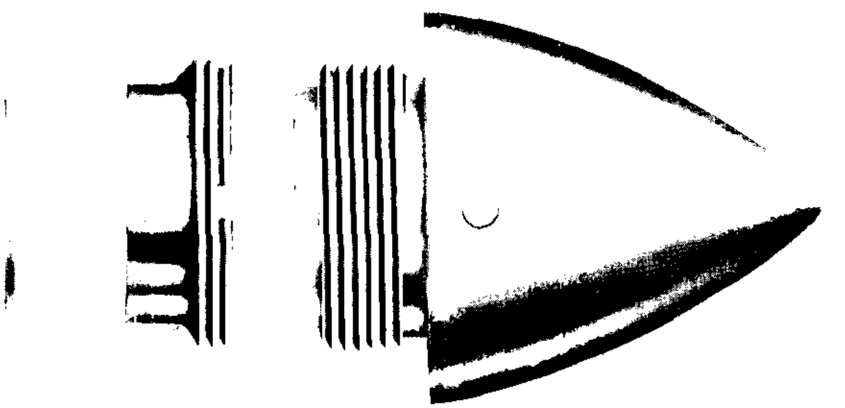
a. Point Detonating Fuzes—Impact Type. These fuzes (fig. 5) are fitted to the standard HE and smoke projectiles. When the projectile is fired, the fuze remains unarmed until it has cleared the muzzle of the gun. For this reason they are called *boresafe* fuzes. On impact, the fuze initiates the detonation or action of the filler. Most point detonating fuzes of the impact type provide superquick or delay action after impact. The complete round is issued with the fuze set at superquick (SQ). When the slot in the setting sleeve is rotated one quarter turn, either direction, the fuze is set at delay and will initiate detonation a predetermined fraction of a second after impact. This delay permits richochet action off firm terrain, a mining action in soft terrain, or penetration of light materiel, prior to detonation. The high explosive projectile may be fitted with a concrete-piercing fuze when needed. This is a special point detonating fuze made of hardened steel. It provides added strength for the HE projectile, giving better penetration when used against concrete fortifications. The type used in tank gunnery includes a predetermined and preset delay action.

b. Base Detonating Fuzes—Impact Type. Some filled armor defeating projectiles (HEAT and HEP) are fitted with a base detonating fuze. Except for their location, base detonating fuzes function in the same general manner as point detonating fuzes.



STANDARD SUPERQUICK—DELAY FUZE

RA PD 212785



CONCRETE PIERCING FUZE

RA PD 104830

Figure 5. Point detonating fuzes—impact type.

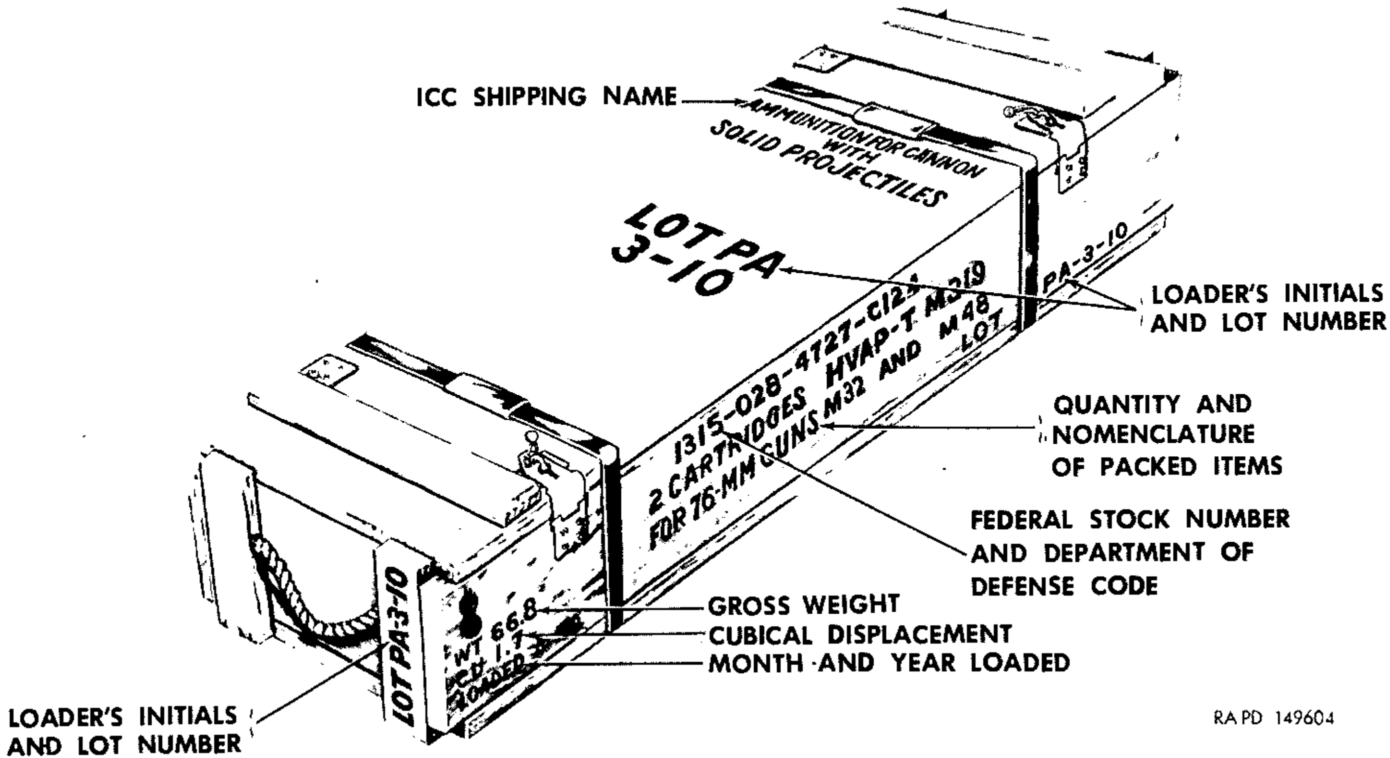


Figure 6. Typical two-round packing box.

24. Ammunition Lot Numbers

A lot number is stenciled on the projectile and base of every round of tank gun ammunition and stamped on its packing box and container (fig. 6). This information is required for records, including reports on condition, functioning, and accidents in which ammunition is involved. To obtain the greatest accuracy in firing, successive rounds should be from the same ammunition lot whenever practicable.

25 Painting and Marking of Main Gun Ammunition

Ammunition is painted to prevent rust and to provide a color code for ease of identification.

Type of Ammunition	*Color of Projectile*
High explosive (any round containing high explosive).	Olive drab; marking in yellow.
Armor-piercing (inert)	Black; marking in white.
Practice (inert)	Blue; marking in white.
Dummy or drill (inert)	Unpainted when made of bronze; otherwise black; marking in white.
Canister	Black; marking in white.
White phosphorus	Grey; one yellow band; marking in yellow.

Note. Further identification of a projectile is made by the shape of the projectile and the marking on the projectile.

Section III. MACHINEGUN AMMUNITION

26. General

Machinegun ammunition is belted in metallic link belts (MLB). In tank gunnery training and in combat, machinegun ammunition should be linked together in a ratio of 4 nontracer to 1 tracer (except when firing subcaliber exercises). Tracer ammunition of some type is included in each belt to be used in automatic fire to enable crewmen to observe the fire of the weapon and consequently adjust (pars. 128–130). As machinegun fire cannot normally be properly adjusted beyond the range of tracer burnout, this determines the maximum effective range of each type machinegun. Even tracers of the same type do not burn out at exactly the same range; the figures used are averages and, therefore, approximate, but accurate enough to use in establishing a maximum effective range.

27. Cartridge Types, 7.62-mm Machinegun

a. Armor-Piercing (AP). Belted with tracer, armor-piercing is the standard combat ammunition used against personnel, unarmored vehicles and equipment, and light-armor-protected vehicles and equipment.

b. Tracer. Burnout occurs at approximately 900 meters (1,000 yards).

c. Ball. Used in training.

28. Cartridge Types, Caliber .30 Machinegun

The same types of ammunition used with the 7.62-mm machinegun are used with the caliber .30 machinegun. In addition, a frangible type, that shatters on impact, is used in training when only limited range facilities are available.

29. Cartridge Types, Caliber .50 Machinegun

a. Armor-Piercing Incendiary (API). Belted with armor-piercing incendiary tracer, this is the standard combat ammunition used against personnel, unarmored vehicles and equipment, light-armor-protected vehicles and equipment, and aircraft.

b. Armor-Piercing Incendiary Tracer (APIT). Burnout occurs at approximately 1,600 meters (1,750 yards).

c. Ball. Used in training.

d. Tracer. Used in training. Burnout occurs at approximately 2,250 meters (2,450 yards).

30. Identification of Machinegun Ammunition by Color

Type of Cartridge	*Color of Tip of Bullet*
Armor-piercing	Black.
Armor-piercing incendiary	Aluminum.
Armor-piercing incendiary tracer	Red and aluminum.
Tracer (7.62-mm and Cal .30)	Orange or red.
Tracer (Cal .50)	Maroon.
Ball	Not painted.
Frangible	Green and white.

Note. Dummy ammunition is identified by three drilled holes in the cartridge case. Blank ammunition is identified by its lack of a projectile.

Section IV. BALLISTICS

31. General

a. Ballistics is the science of the motion of projectiles. From the time a projectile leaves its starting place until it comes to rest, it passes through three phases—interior ballistics, exterior ballistics, and terminal ballistics.

b. For the most part, the tank crew cannot control the inherent ballistic characteristics of the gun-ammunition combination. However, by diligent application of correct tank gunnery techniques and approved cleaning, inspection, and maintenance procedures, the crew can exploit the capabilities of the gun and ammunition.

32. Interior Ballistics

a. Interior ballistics concerns everything that takes place inside the gun tube. It deals with the temperature, volume, and pressure of the gases into which the propellant in the chamber of the gun is changed by combustion, and with the effect of the expansion of these gases upon the gun, mount, and projectile. When the firing mechanism is actuated, the firing pin strikes the primer or an electrical charge is sent through the firing pin to the primer, initiating the burning of the propellant. The propellant burns gradually (relatively), producing a large volume of gas while the projectile is still in the tube. This gas expands, producing pressure in all directions in the chamber and tube. The projectile moves forward, accelerating rapidly in the tube, while the gun moves rearward in recoil. As the projectile moves forward, the rotating bands are engraved by the rifling in the bore and fit the bore snugly (although they may not be rigidly attached to the projectile, par. 19), sealing the propellant gases behind the projectile. Because the gun bore is rifled, rotating bands that are attached to the body cause the projectile to spin as it travels forward. The gas pressure in the tube is still high when the projectile leaves the muzzle; this accounts for the large muzzle blast of tank guns. A study of interior ballistics permits the determination of all the factors that give a projectile its orientation, velocity, and rate of spin. Some of these factors are weight of charge, type and density of propellant, length of bore, and chamber volume. These factors determine the design of the gun and recoil system.

b. Interior ballistic performance is greatly affected by such factors as variations of powder temperature, tube temperature and wear, imperfect rotating bands, and extraneous matter in the gun bore. The crew can obtain the best and most consistent results by insuring that ammunition is not exposed to direct rays of the sun or temperature extremes, that gun tubes are cleaned before and after firing, and that ammunition is stowed in such a manner as to prevent damage.

33. Exterior Ballistics

a. Exterior ballistics is concerned with the path of a projectile from the time it leaves the gun until it strikes the target or bursts in the air at a desired point. The path of flight of the projectile is called the trajectory. Some of the factors affecting the trajectory are—

(1) Direction in which the gun is pointed (elevation and deflection).

(2) Projectile velocity.

(3) Drag on the projectile caused by the resistance of the air through which it passes.

(4) Drift of the projectile.

(5) Effect of wind.

(6) Force of gravity.

b. To compensate for the force of gravity, the gun must be pointed above the line of sight to the target. The angle above the line of sight to which the gun must be elevated to cause a given projectile to strike a target at a given range is termed the superelevation angle (fig. 7). Generally, the lower the projectile velocity and the greater the range, the greater the superelevation angle required. High-velocity guns used in tanks need comparatively little superelevation because, while technically there is no projectile that has a perfectly flat trajectory, their projectiles describe comparatively flat trajectories.

34. Terminal Ballistics

Terminal ballistics is concerned with the effect of the projectile on the target. This effect is determined by the characteristics of the projectile, fuze, and target. Different projectiles produce varying effects, such as—

a. Blast and fragmentation.

b. Penetration.

c. Incendiary.

d. Smoke.

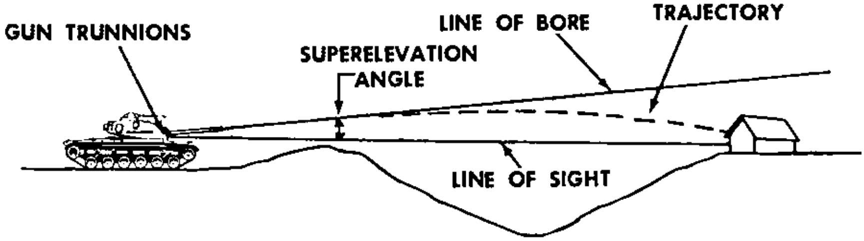


Figure 7. Superelevation angle.

PART THREE
FUNDAMENTALS OF TANK GUNNERY

CHAPTER 4
TANK FIRE CONTROL EQUIPMENT

Section I. INTRODUCTION

35. General

This chapter discusses the capabilities and limitations of fire control equipment and how this equipment is adjusted and used in accurate and rapid target engagement. A thorough knowledge of fire control equipment, its use, and its adjustment is essential to good gunnery. Since use of fire control equipment must also include an understanding of angular measurements, the mil and mil relation as they apply to tank gunnery also are discussed. Fire control equipment includes ranging and sighting equipment, auxiliary fire control equipment, observation and vision devices, and various other types of equipment that aid in laying tank guns.

Section II. THE MIL AND MIL RELATION

36. General

a. The mil is the basic unit of angular measurement used in tank gunnery. Tank weapons may be laid for deflection and elevation by being moved right (or left) and up (or down) a specified number of mils. Tank fire control equipment is graduated in mils to conform to the mil method of measurement. As a matter of comparison, there are approximately 18 mils in one degree (1° equals 17.777778 mils).

b. As a unit of angular measurement the mil is equal to $\frac{1}{6,400}$ part of a circle (fig. 8). One mil, for tank gunnery purposes, subtends a width (or height) of 1 meter at a range of 1,000 meters (fig. 9). When the sides of a 1-mil angle are extended until they are 2,000 meters long, the width between the ends of the lines is 2 meters.

c. The relationship of the angle, the length of the sides of the angle, and the width (height) between the sides remains constant. Figure 10 demonstrates this constant relation as the angle in-

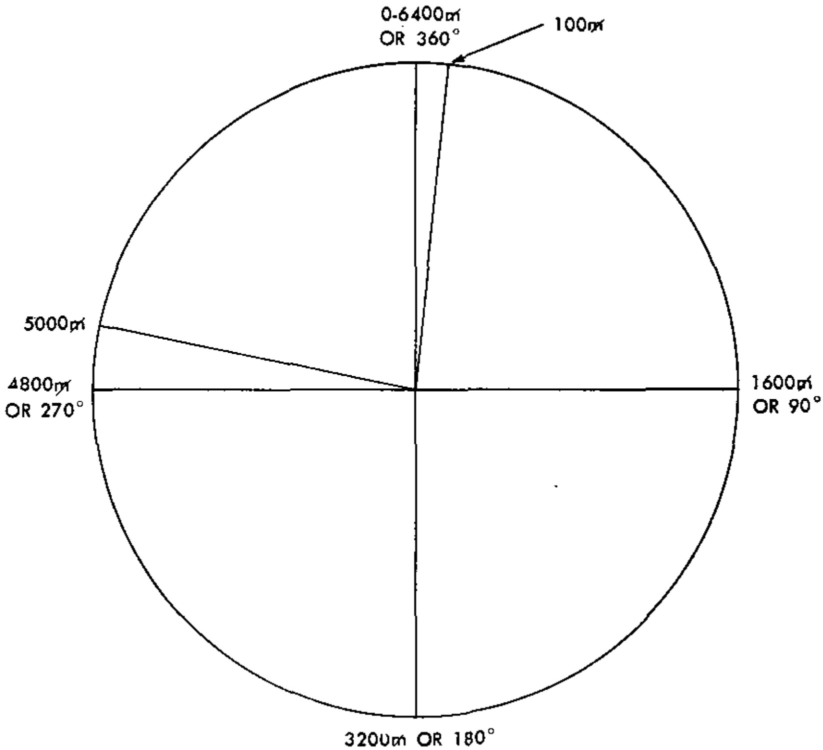


Figure 8. A comparison of mils and degrees.

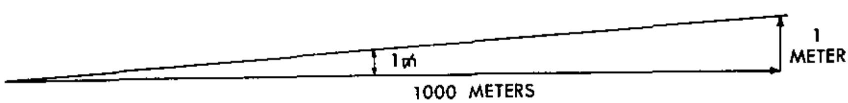


Figure 9. The mil relation at 1,000 meters.

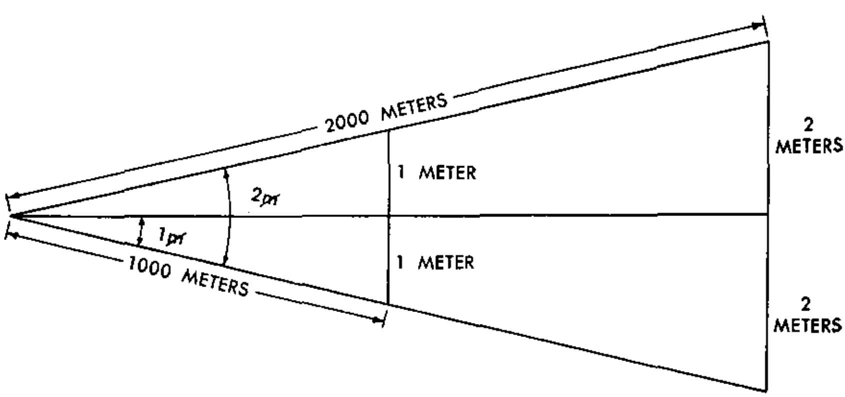


Figure 10. The mil relation is constant—

1 mil at 1,000 meters equals 1 meter
1 mil at 2,000 meters equals 2 meters
2 mils at 1,000 meters equals 2 meters
2 mils at 2,000 meters equals 4 meters.

creases from 1 mil to 2 mils and the range increases from 1,000 meters to 2,000 meters.

37. The Mil Relation

a. The relationship of the size of the angle ($\not{m}$), the length of the sides (R), and the width between the ends of the sides (W) is expressed as the mil relation or: $\dfrac{W}{R \times \not{m}}$ (fig. 11).

b. Because the mil relation is constant, other units of measure such as yards, feet, or inches may be substituted for meters in expressing width or range; however, the relation holds true only if both W and R are expressed in the same unit. For example, if the sides of a 1-mil angle are extended to 1,000 yards, the width between the ends of the sides is 1 yard.

c. The mil relation may be converted into a formula by removing the factor that is to be determined.

$$\text{Thus } \frac{W}{R \times \not{m}} \text{ becomes } W = R \times \not{m}$$

$$\text{or } R = \frac{W}{\not{m}}$$

$$\text{or } \not{m} = \frac{W}{R}$$

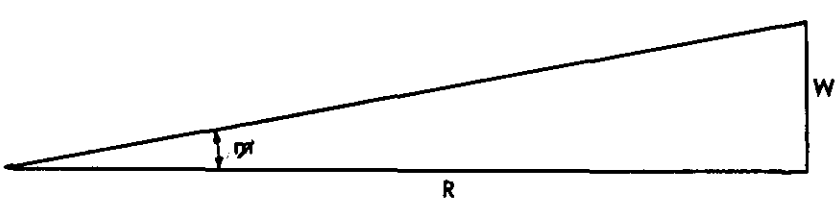
As a memory aid, the word WORM may be used, meaning W over $R \times \not{m}$ or

$$\frac{W}{R \times \not{m}}$$

38. Use of the Mil Relation

a. General. The mil relation is used in tank gunnery to compute 1 of 3 factors—range, mil angle, or width (height). When two of the factors are known, the third can be determined.

(1) *Range.* To determine range, use one of the methods dis-



W = WIDTH (OR HEIGHT) IN METERS

R = RANGE IN THOUSANDS OF METERS

$\not{m}$ = ANGLE IN MILS

Figure 11. The mil relation.

cussed in chapter 5. The method used will influence the accuracy of the *W* or $\not{m}$ factor determined. When range is known, it is converted to an *R* factor before being used in the mil relation. An *R* factor is range in thousands of units; e.g., a range of 2,500 is divided by 1,000 and the result is an *R* factor of 2.5. If the mil relation is used to determine range, the computations then result in an *R* factor. This is multiplied by 1,000 to obtain range; e.g., an *R* factor of 1.7 multiplied by 1,000 equals a range of 1,700.

(2) *Width (height)*. Determination of *W* is based on prior knowledge of certain dimensions of objects or expected targets. Tank commanders should familiarize themselves with the dimensions of enemy equipment and the dimensions of common objects such as width of roads and height of telephone poles. How accurately these dimensions are known will affect the accuracy of the mil relation when determining *R* or $\not{m}$. The mil relation holds true whether the *W* factor is in a horizontal or vertical plane (fig. 12), if the mil angle is measured in the same plane.

(3) *Mil angle*. The mil angle is required to determine range or width (height). The accuracy of the mil relation depends upon accurate measurement of the mil angle to the nearest mil. It may be determined by using any instrument that is graduated in mils. Normally, the binocular reticle (fig. 17) will be used; however, time permitting, a tank azimuth indicator may be used to measure a horizontal angle by laying the aiming cross on the right edge of the object to be measured and zeroing the azimuth indicator; then, by traversing left until the aiming cross is on the left edge of the object, the angle may be read directly from the azimuth indicator. For small angles the reticle in the sight may be used, the lead lines being used to measure horizontal angles, and, if the range lines are graduated in mils (nonballistic reticles), they can be used to measure vertical angles. The more accurate the method used in determining the mil angle, the more accurate will be the range or width determined by the mil relation. For angles of 400 mils or less, the mil relation is accurate enough for use in computing firing data.

Note. Results of the mil relation are carried out to one decimal point only, and factors used in the computations, if fractional, are rounded off to the nearest decimal point, i.e., one-half or more to the next higher number and less than one-half to the next lower number.

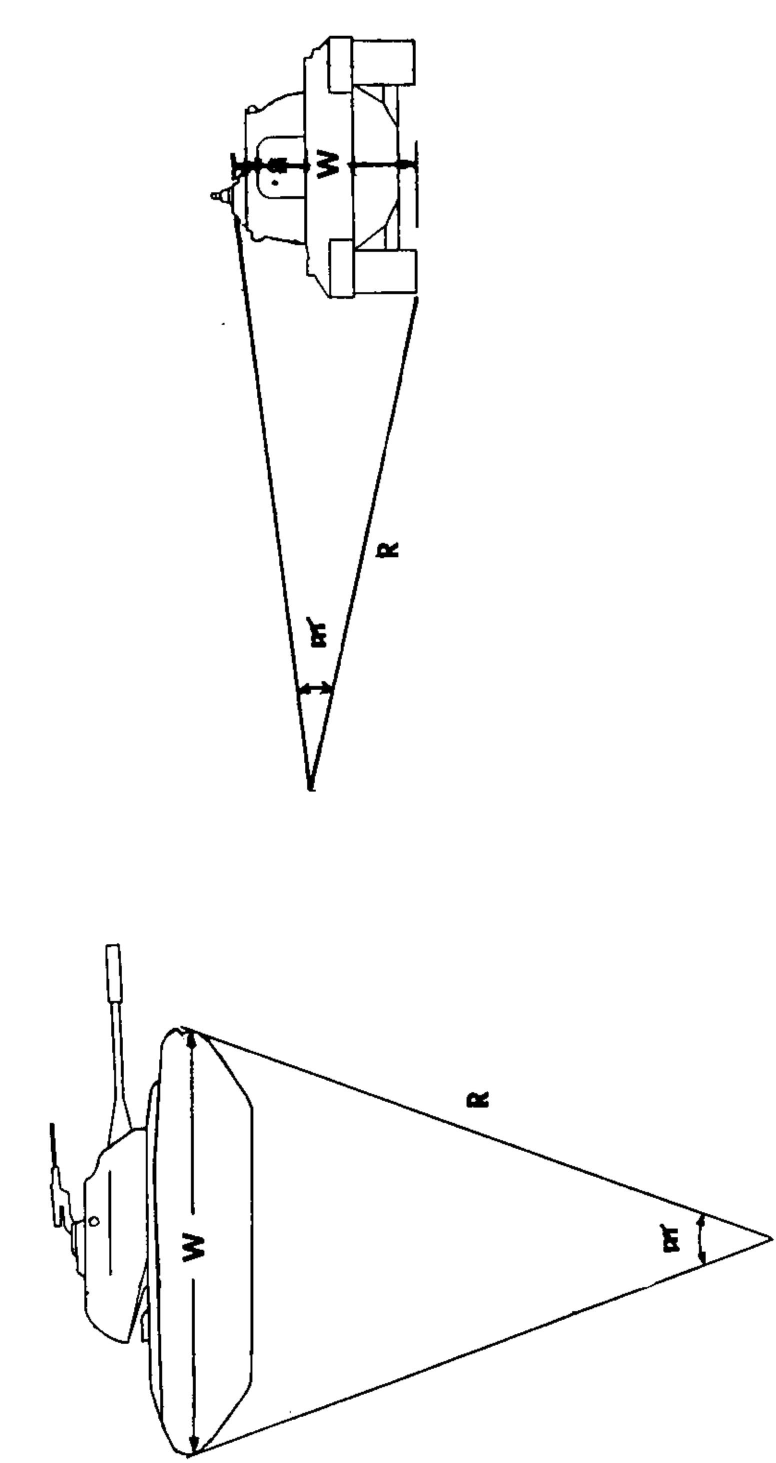


Figure 12. The mil relation is applicable in all planes.

b. Determining Range.

(1) *General.* To determine range, the mil angle and the width (height) must be known. Figure 13 illustrates a situation in which the tank commander must determine the range to the target.

Remember:	Remove unknown:
$\dfrac{W}{R \times \not m}$	$\dfrac{W}{? \times \not m}$

(2) *Procedure.*

(*a*) It is known that the enemy tank is approximately 7 meters long (*W*).

(*b*) Using his binocular, the tank commander determines that the tank measures 5 mils ($\not m$) in length.

(*c*) By removing the *R* factor from the mil relation,

$$\frac{W}{R \times \not m} \quad \text{becomes } R = \frac{W}{\not m}$$

(*d*) Substitute the two known value for *W* and $\not m$ and solve for R:

$$R = \frac{W}{\not m} = \frac{7}{5} = 1.4$$

(*e*) Since *R* is in thousands of meters, multiply the answer (1.4) by 1,000; $1.4 \times 1{,}000 = 1{,}400$ meters, the range to the enemy tank.

c. Determining Mil Angle.

(1) *General.* It may be necessary to solve for the mil angle ($\not m$) when determining the safety factor for friendly troops (minimum elevation), when determining angle of site, or when the mil angle cannot be measured directly with instruments. To determine the mil angle, the range and width must be known. Figure 14 depicts a situation in which the tank commander must determine the mil angle necessary to add a 5-meter safety factor to the top of the mask.

Remember:	Remove unknown:
$\dfrac{W}{R \times \not m}$	$\dfrac{W}{R \times ?}$

(2) *Procedure.*

(*a*) Using the rangefinder or some other method of range determination, the tank commander determines that the range to the hill mask is 1,000 meters (*R*).

(*b*) The height above the mask for troop safety is 5 meters (*W*).

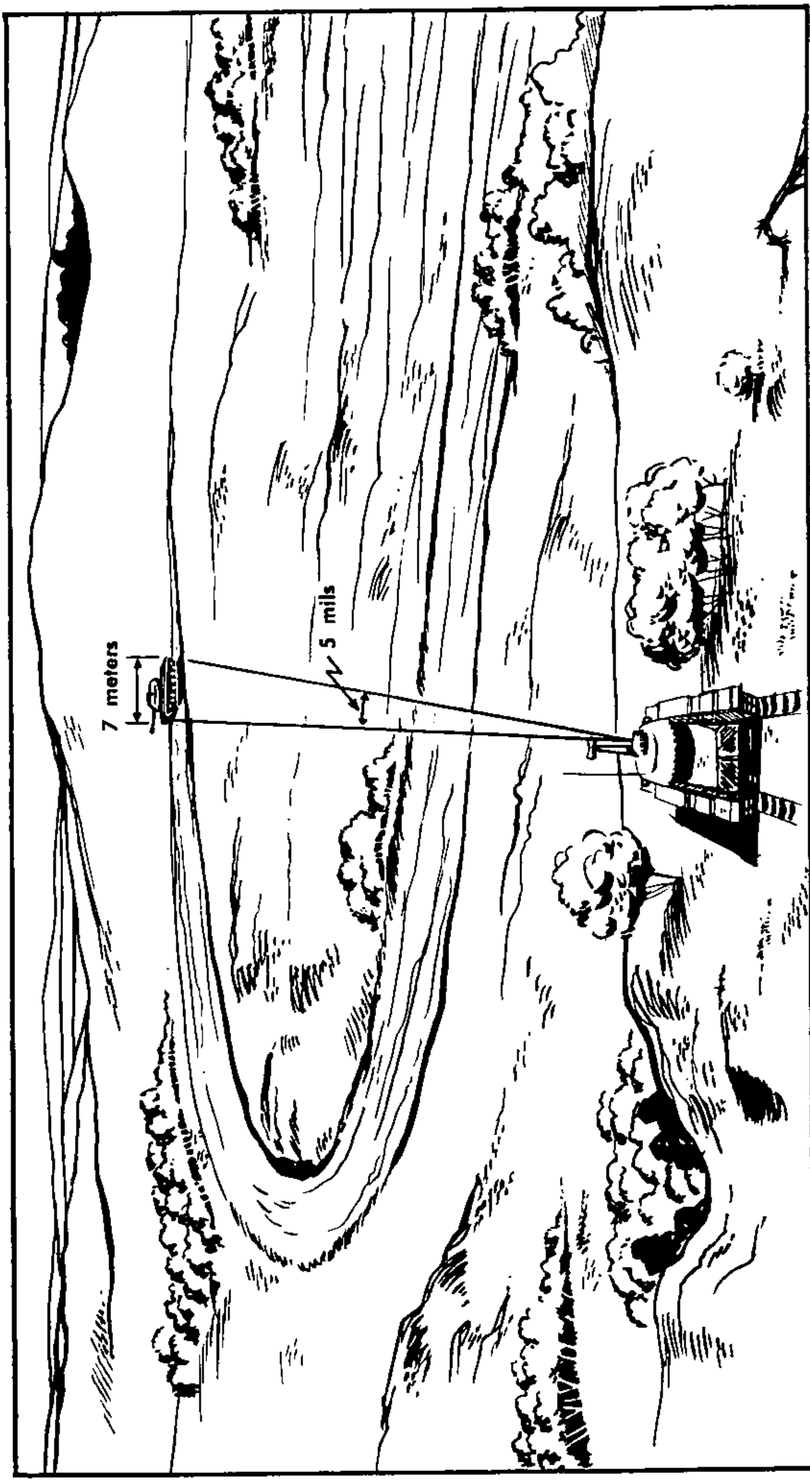


Figure 13. Determining the range to a target using the mil relation.

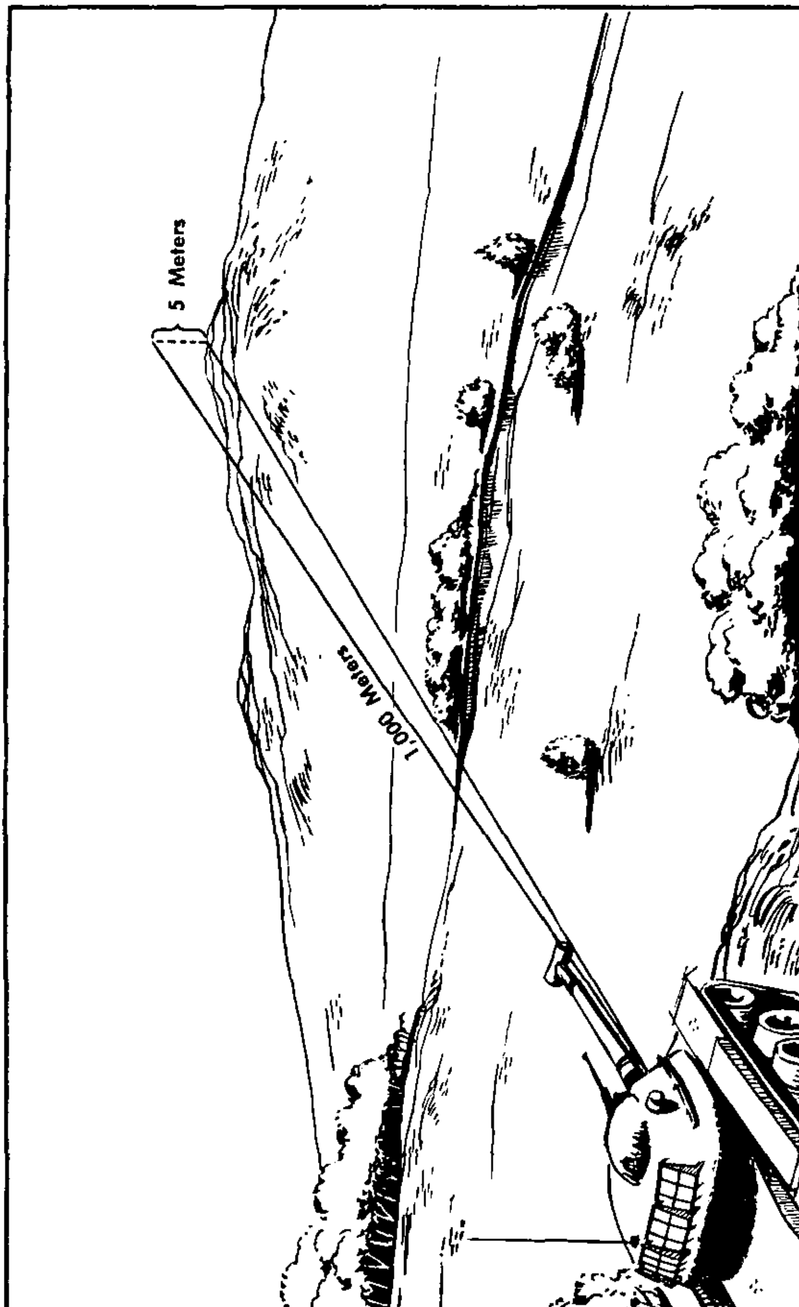


Figure 14. Determining the mil angle.

(c) By removing the $\text{m}\!\!\!/$ factor from the mil relation,

$$\frac{W}{R \times \text{m}\!\!\!/} \text{ becomes } \text{m}\!\!\!/ = \frac{W}{R}$$

(d) Substitute the two known values for W and R and solve for $\text{m}\!\!\!/$:

$$\text{m}\!\!\!/ = \frac{W}{R} = \frac{5}{1} = 5 \text{ mils.}$$

d. Determining Width.

(1) *General.* It is necessary to solve for width (W) when adjusting indirect fire, determining clearance for bridges and underpasses, and determining the difference in elevation between gun and target. To determine width by using the mil relation, the mil angle ($\text{m}\!\!\!/$) and the range (R) must be known. Figure 15 illustrates a situation in adjusting artillery fire. In order to correct for deviation, the observer must determine the width (W) between the volley and his observer-target (OT) line.

Remember:

$$\frac{W}{R \times \text{m}\!\!\!/}$$

Remove unknown:

$$\frac{?}{R \times \text{m}\!\!\!/}$$

(2) *Procedure.*

(a) The range (R) from the observer to the target is 3,000 meters.

(b) Using his binocular, the observer determines that the angle between the OT line and the volley measures 20 mils ($\text{m}\!\!\!/$).

(c) By removing the W factor from the mil relation,

$$\frac{W}{R \times \text{m}\!\!\!/} \text{ becomes } W = R \times \text{m}\!\!\!/.$$

(d) Substitute the two known values for R and $\text{m}\!\!\!/$ and solve for W. $W = R \times \text{m}\!\!\!/ = 3 \times 20 = 60$ meters, the width between the OT line and the volley.

39. Conversion Table

The following conversion table will be of assistance in tank gunnery. The first column of figures should be used for quick conversion; the second column for precise calculations.

To convert—	*Multiply number by—*		
meters to yards	1.1	or	1.093611
yards to meters	.9	or	.914402
feet to meters	.3	or	.304801
meters to feet	3.3	or	3.280833
mils to degrees	.06	or	.056250
degrees to mils	17.8	or	17.777778

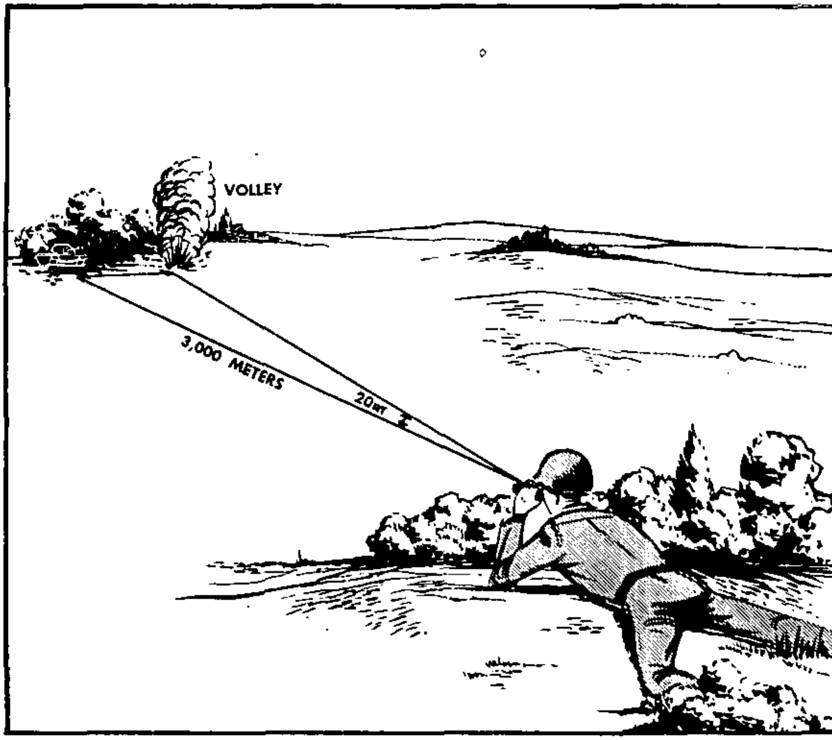


Figure 15. Determining the width between target and volley.

Section III. THE BINOCULAR

40. General

Continuous evaluation of the terrain and actions of the enemy, through general observation, is an important function of combat leaders. The binocular enables a tank commander to accomplish this observation. Tank crewmen also use the binocular for locating targets, adjusting fire, and measuring horizontal and vertical angles.

41. Description of Binocular

The binocular (fig. 16) is an optical instrument consisting of two telescopes hinged together for binocular vision. The reticle (fig. 17) in the left telescope has both horizontal and vertical scales. The horizontal scale is 100 mils long graduated in 10-mil intervals, with 50 mils right and 50 mils left of the center of the field of view. There are three vertical scales. Infantrymen use the vertical scale in the right half of the field of view in adjusting indirect machinegun fire when using the auxiliary aiming point method. Tankers use it only to denote the 30-mil mark on the

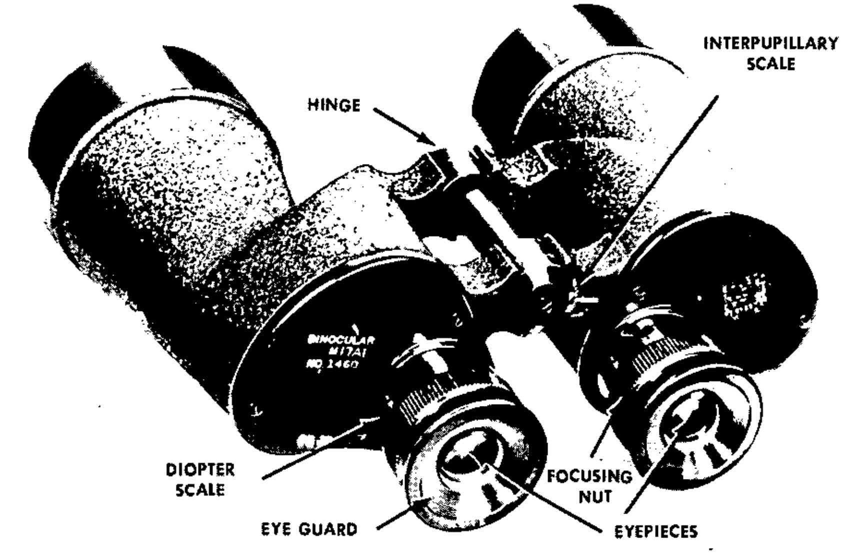


Figure 16. The binocular.

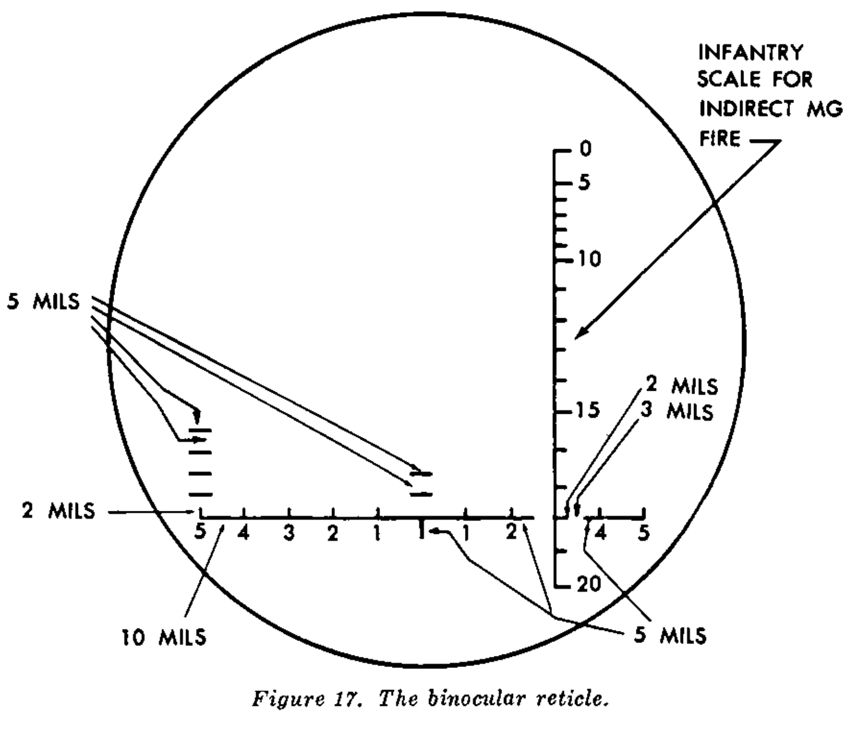


Figure 17. The binocular reticle.

right side of the horizontal scale. The other vertical scales, one above the center and one above the left edge of the horizontal scale, consist of horizontal lines 5 mils long and spaced 5 mils apart vertically. These are for measurement of vertical angles.

42. Use of Binocular

a. Setting Interpupillary Distance. To set the binocular so that the eyepieces are the same distance apart as the eyes, open the binocular at the hinge and look through the eyepieces at the sky. Close the binocular until the two circles appear as one sharply defined circle. Note the reading on the interpupillary scale, for future use with the binocular or binocular-type rangefinder. This reading remains constant for that particular individual.

b. Focusing (Diopter Setting).

(1) Set both diopter scales at +4 and, with both eyes open, look through the eyepieces at a distant object.

(2) Cup the palm of one hand over the lens of one telescope and slowly turn the focusing nut of the other telescope until the object is clearly defined. Once the object becomes sharp, stop turning the focusing nut and note the reading.

(3) Reset the scale at +4 and repeat this procedure for the same telescope. Use the greater plus reading (or smallest minus reading) of the two trials.

(4) Repeat the procedure in (2) and (3) above, for the other telescope. It may be necessary to make a slight readjustment of the left focusing nut to define the reticle clearly.

(5) Note the diopter scale reading for each eyepiece for future use with the binocular.

c. Observing.

(1) Holding the binocular with both hands, press the eyepieces lightly to the eyes (fig. 18).

(2) The thumbs should be bent and held at the side of the eyes to obscure light. Do not look through the binocular any longer than necessary at one time as this may cause eye strain.

(3) When observing, look at a specific area for a short period of time. To examine a wide area, observe sections of the terrain at a time.

d. Use of the Reticle. The binocular should be held so that the reticle appears superimposed on the observed area. The reticle is

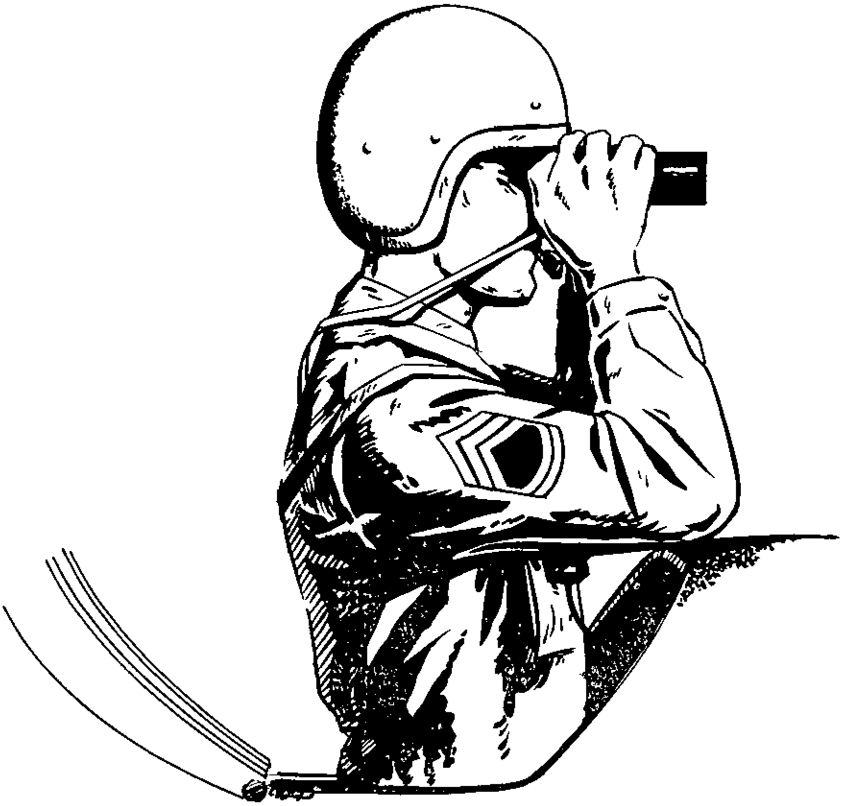


Figure 18. Proper method of observing with the binocular.

used to measure horizontal and vertical angles. Measurement to the nearest mil is of primary importance.

(1) *Measuring horizontal angles* (fig. 19). To measure the horizontal angle between two points, move the binocular so that both points are lined up along the horizontal scale. The number of mils between the two points is the horizontal angle. If the points are less than 5 mils apart, place 1 end of a 5-mil horizontal line on 1 point of the object, then interpolate the number of mils to the other. If the points are more than 5 but less than 50 mils apart, place the zero graduation on 1 point, then read the number of mils to the other. If the points are between 50 and 100 mils apart, place 1 end graduation (numeral 5) on 1 point and read the number of mils to the other point (remember that there are 50 mils between each end graduation and the zero graduation). If the points are more than 100 mils apart, select 1 or more points between them, make 2 or more measurements, and add

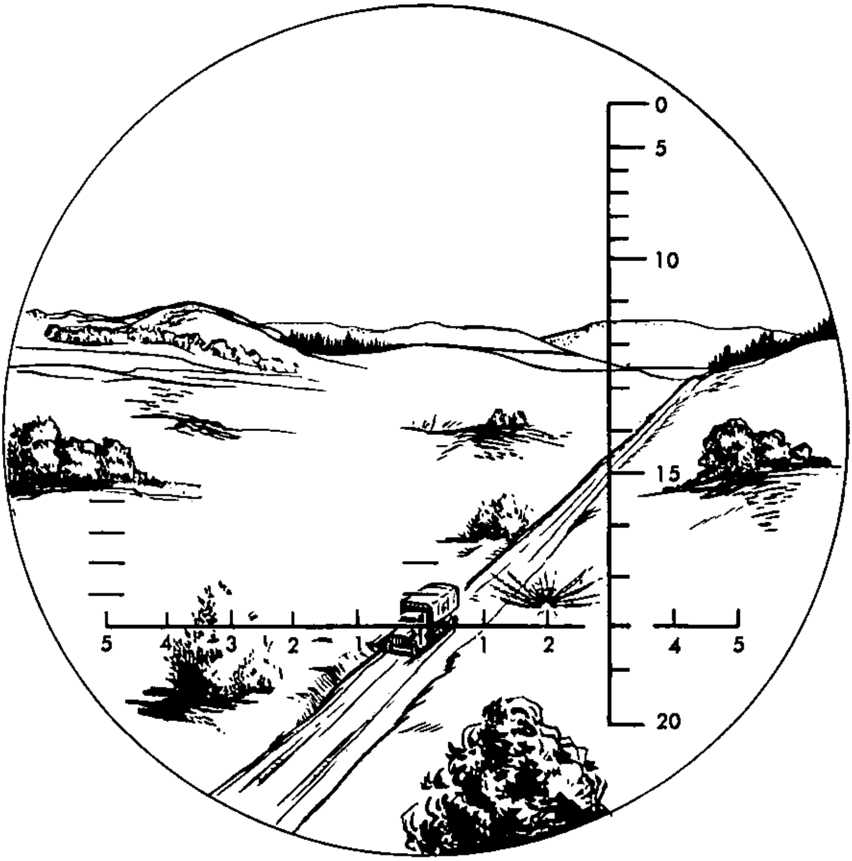


Figure 19. Measuring a horizontal angle with the binocular. The burst is 20 mils right of the truck.

them together. If 1 point does not appear exactly on a graduation, interpolate the number of mils less than 10.

(2) *Measuring vertical angles* (fig. 20). To measure the vertical angle between two points, move the binocular so that the bottom point is on either the zero or the left graduation (numeral 5) of the horizontal scale. The number of mils between the bottom and the upper points, as read on the vertical scale, is the vertical angle. Interpolate between the 5-mil graduations. To measure larger angles (over 20 mils), make two or more measurements and add them together or tilt the binocular sideways and use the horizontal scale.

Note. Do not use the numbered vertical scale (infantry) for these measurements.

e. Position of the Binocular. When using the binocular, adjust the carrying strap so that the binocular will rest high on the chest. In this position it is readily available and is less likely to swing and strike against the turret or other parts of the tank. Keep the binocular in its carrying case when it is not in use.

43. Care and Preservation of Binocular

a. Care. The binocular requires careful handling. It should be frequently inspected for moisture, dirt, fungus, grease, and damaged or tilted reticles. The reticle should be in the correct plane at an interpupillary scale setting of 64 (64 millimeters between centers of the eyepieces of the telescopes). Since the reticle is in the proper plane at only one interpupillary scale setting, units cannot expect to detect small amounts of tilt in a binocular reticle. To obtain the correct setting, the interpupillary scale must be set by Ordnance. If there is doubt about whether a reticle is tilted, it should be inspected by Ordnance.

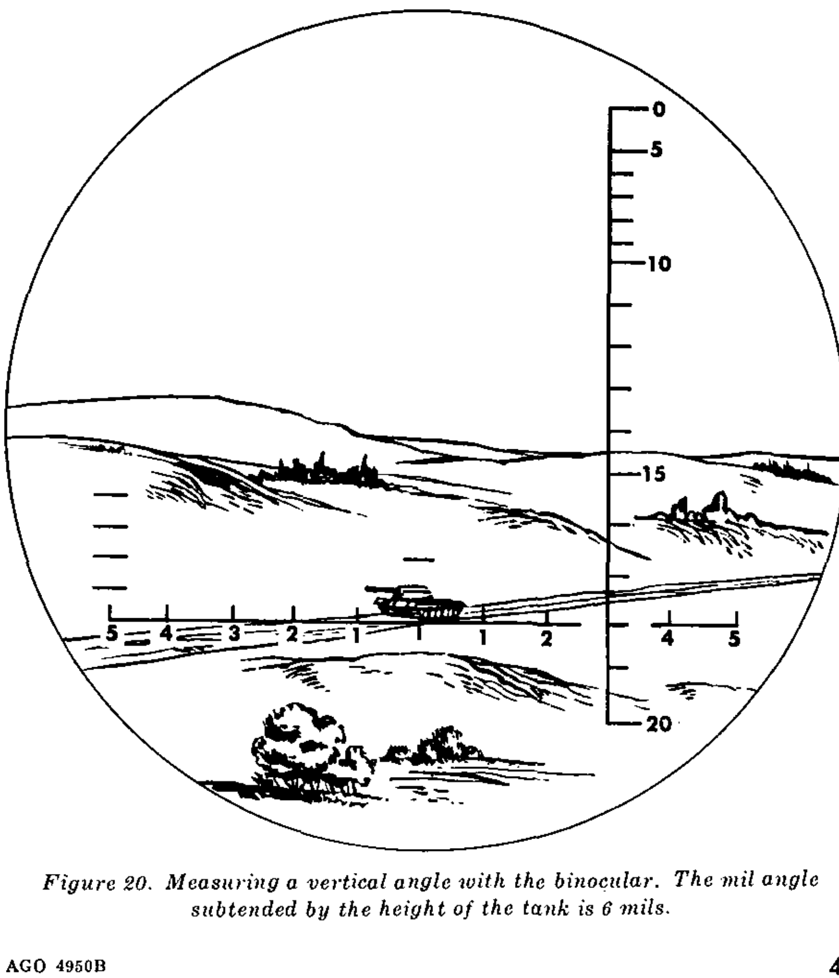


Figure 20. Measuring a vertical angle with the binocular. The mil angle subtended by the height of the tank is 6 mils.

b. Cleaning and Preservation. Wipe the binocular dry immediately after use in wet weather. Use only authorized lens cleaning materials.

c. Disassembly. The eyeguards may be removed to facilitate use of the binocular by personnel wearing glasses. Further disassembly is performed by Ordnance only.

Section IV. DIRECT-FIRE SIGHTS

44. General

a. Tank direct-fire sights are optical devices used in laying the gun for elevation and deflection when the target is visible through these sights. Tank direct-fire sights have the following characteristics:

(1) Move with the gun.

(2) Incorporate a reticle that can be moved with or independently of the gun.

(3) Have a means of reticle illumination.

Note. Some types of direct-fire sights have an infrared capability.

b. Direct-fire sights are mounted for use by the gunner and the tank commander. The gunner has two direct-fire sighting systems for use with the main gun or coaxial machinegun, primary and secondary. The tank commander has a direct-fire sighting system for use with the main gun or coaxial machinegun and, on tanks equipped with a cupola-mounted machinegun, he has a separate system for use with this weapon. Types of direct-fire sights are periscopes, telescopes, and range finders.

45. Periscopes

Periscopes are mounted for use with the main gun, coaxial machinegun, and cupola-mounted machinegun. Periscopes used with the main gun (fig. 21) provide two separate fields of view: one a magnified field with a superimposed reticle (fig. 26) for use as a direct-fire sight and the other a nonmagnified (unity) field for observation purposes. In some periscopes, there is a reticle (fig. 27) that can be projected into the nonmagnified field of view for use when the coaxial machinegun is fired. Periscopes used with the cupola-mounted machinegun provide a magnified field of view with a superimposed reticle (fig. 28) that is used as a direct-fire sight when the caliber .50 machinegun is fired.

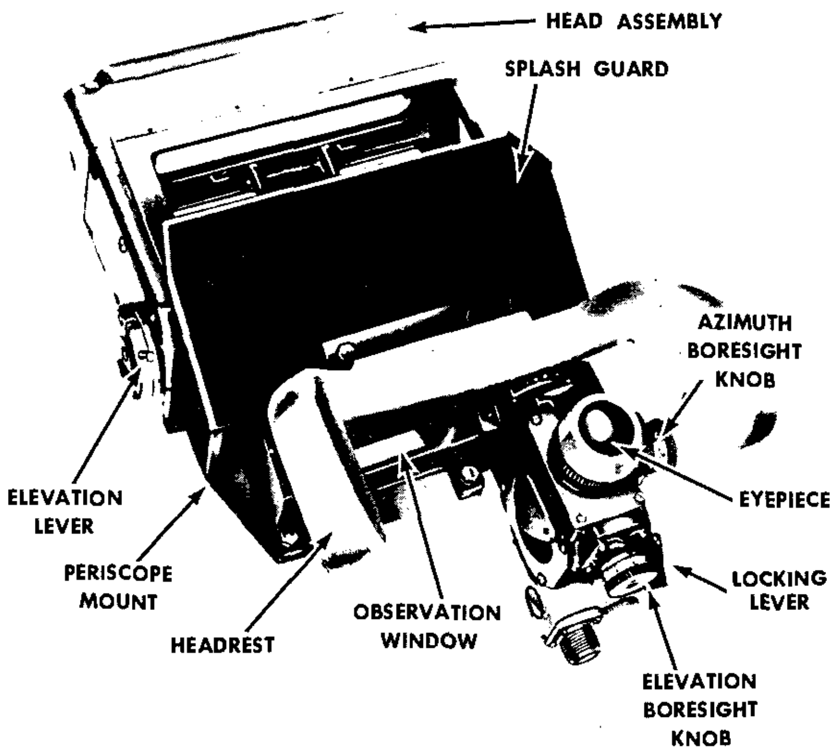


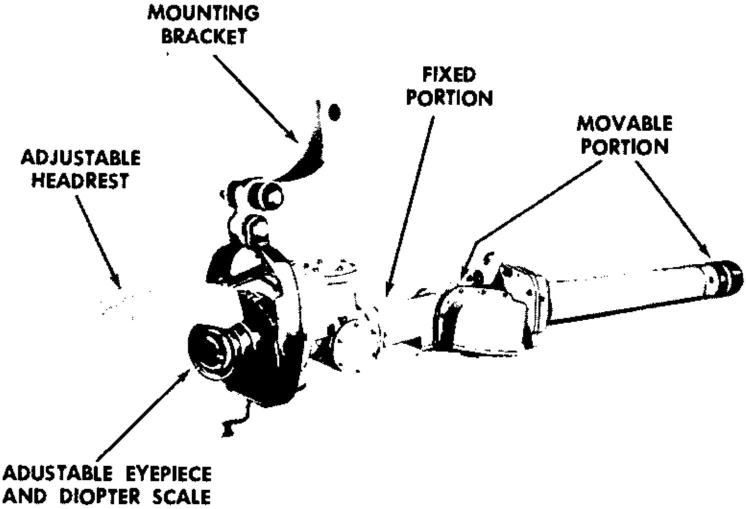
Figure 21. Periscope.

46. Telescopes

Telescopes are provided for use with the main gun and are of two types: tubular (straight tube) and articulated (jointed) (fig. 22). All telescopes provide a magnified field of view with a superimposed reticle or reticles (fig. 25) and are fixed in a telescope mount that in turn is fixed to the combination gun mount. The tubular telescope contains one reticle and the entire telescope moves with the gun. The articulated telescope has two or more selectable reticles and only the body of the telescope moves with the gun. The eyepiece end of the telescope is fixed in place for easier viewing. The separate movement of the body of the telescope is made possible by an articulated portion between the eyepiece and the body.

47. Range Finders

Some tanks are equipped with a rangefinder for use by the tank commander as a means for determining range and as a direct-fire sight. Rangefinders are of two types—stereoscopic and coincidence



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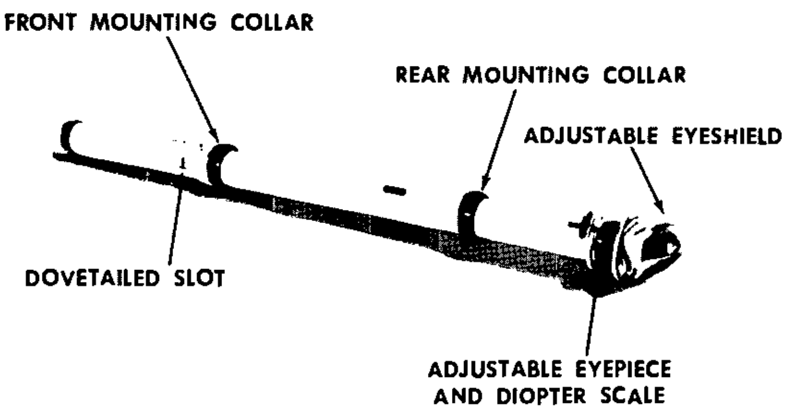

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Figure 22. Telescopes.

(fig. 23). Range is determined with the stereoscopic range finder by moving the ranging reticle in depth until the lower bar of the reticle appears at the same range as the target. Range is determined with the coincidence rangefinder by merging two images of the target. Depth perception is a requirement for operating the stereoscopic rangefinder, but not for operating the coincidence rangefinder. Both types of rangefinders incorporate an etched nonballistic reticle and an illuminated nonballistic reticle to be used as a direct-fire sight. The illuminated reticle is an auxiliary reticle that can be used when firing during periods of poor visibility.

48. Direct-Fire Control Systems

a. Direct-fire control systems are peculiar to the models and types of tanks on which they are used. The systems may be either rangefinder-computer-periscope, with necessary linkage; periscope-ballistic unit, with necessary linkage; or a telescope mounted coaxially with the main gun. Figure 24 illustrates a representative direct-fire control system.

b. The purpose of a direct-fire control system is to provide means of accurately laying the gun. The two elements necessary to lay any weapon are direction (deflection) and range (elevation).

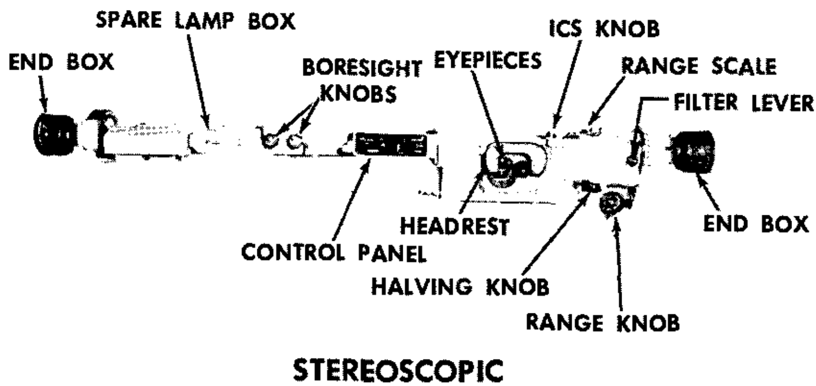


Figure 23. Rangefinders.

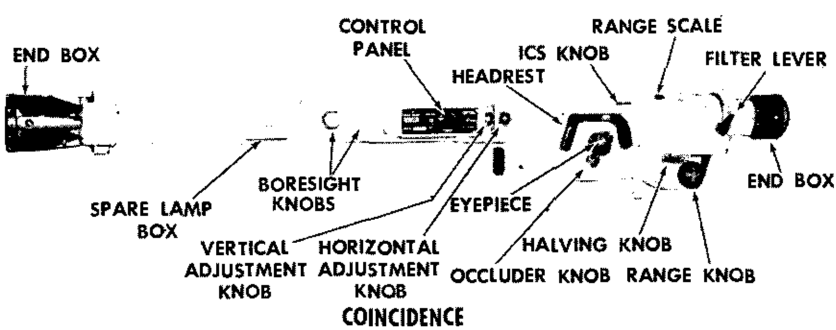


Figure 23—Continued.

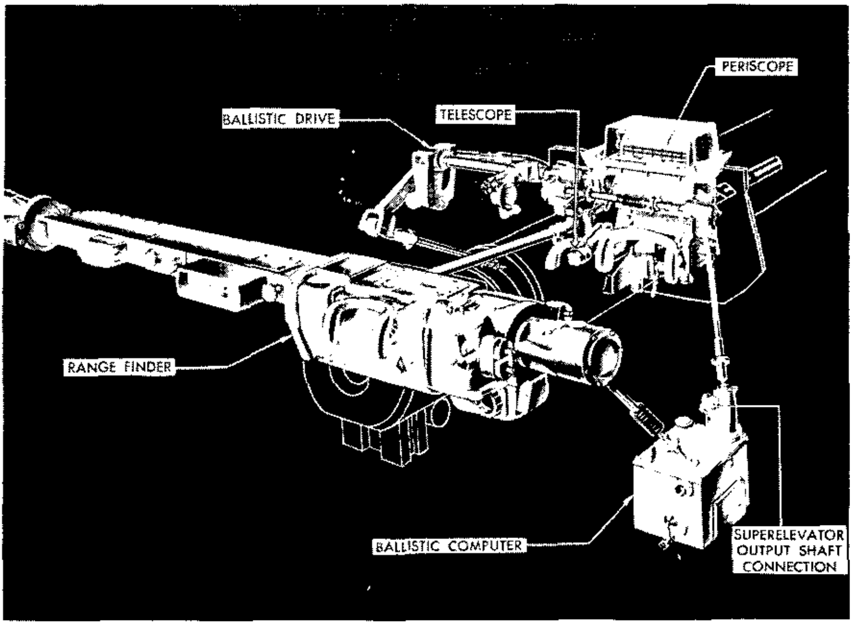


Figure 24. A representative direct-fire control system.

The gun is laid for direction when the correct point of the reticle is laid on the aiming point. The gun is laid for range when the correct point of the reticle is laid on the target and the super elevation angle (par. 33) is introduced between the line of sight and axis of the gun. The superelevation angle is introduced through the components of the direct-fire control system in one of three ways: by a computer or a ballistic unit moving the sight while the gun remains stationary; by a computer moving the gun while the sight remains stationary; or by being built into the reticle (ballistic) of a sight that moves with the gun.

49. Sight Reticles, Filters, and Coated Optics

a. Reticles. A direct-fire sight reticle consists of a pattern of marks (vertical (range) and horizontal (lead) lines and, in some sights, a circle) placed in the field of view of an optical instrument to provide reference points for laying the gun and adjusting fire. Reticles can be used also to measure horizontal and vertical angles. There are two categories of sight reticles, ballistic (figs. 25 and 28) and nonballistic (figs. 26 and 27). The lead lines on both the ballistic and the nonballistic reticles have mil values. Both types can be either an etched reticle (the pattern marked on a piece of glass within the field of view) or an illuminated (auxiliary) reticle (projected into the field of view by illumination as required).

(1) *Ballistic reticles.* Ballistic reticles are graduated for use with a particular type of ammunition. On these reticles, range lines are graduated in meters or yards. The appropriate range line is laid on the center of vulnerability of the target to obtain the correct sight picture for firing the first round. If a ballistic reticle is used when a type of ammunition is fired other than the one for which it is graduated, a corrected range setting must be determined (par. 74).

(2) *Nonballistic reticles.* Nonballistic reticles have range lines with mil values and are used in conjunction with a computer or ballistic unit for firing any type tank gun ammunition without a corrected initial sight setting. With this reticle, the aiming cross or center of the circle is laid on the center of vulnerability of the target for the first round fired, after range and ammunition are introduced into the fire control system.

(3) *Use in fire adjustment.* For use of both types of reticle in making adjustments in firing, see paragraphs 111, 113, and 117.

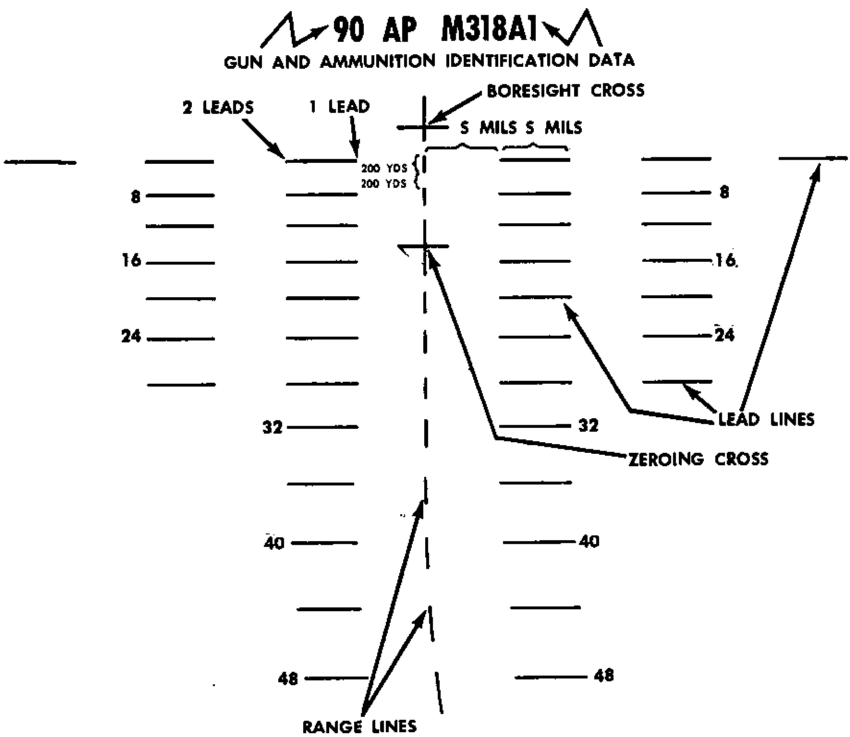


Figure 25. Ballistic reticle.

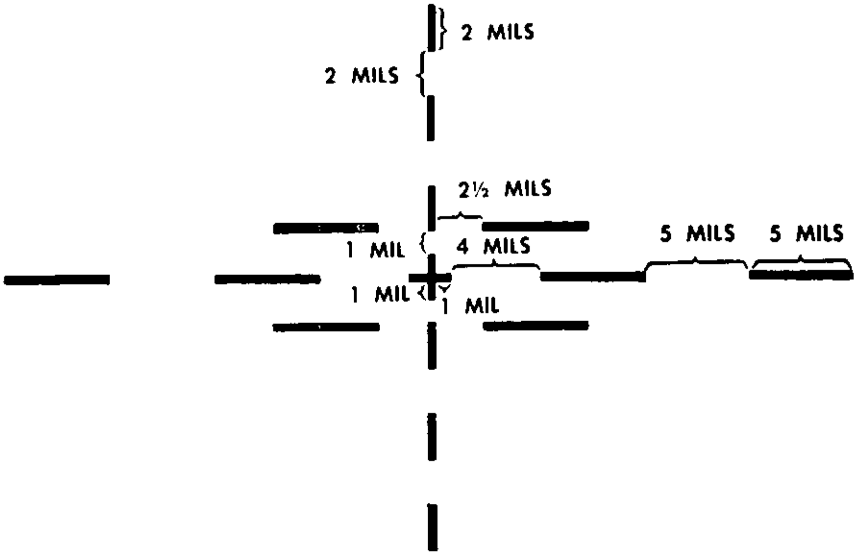


Figure 26. Nonballistic reticle.

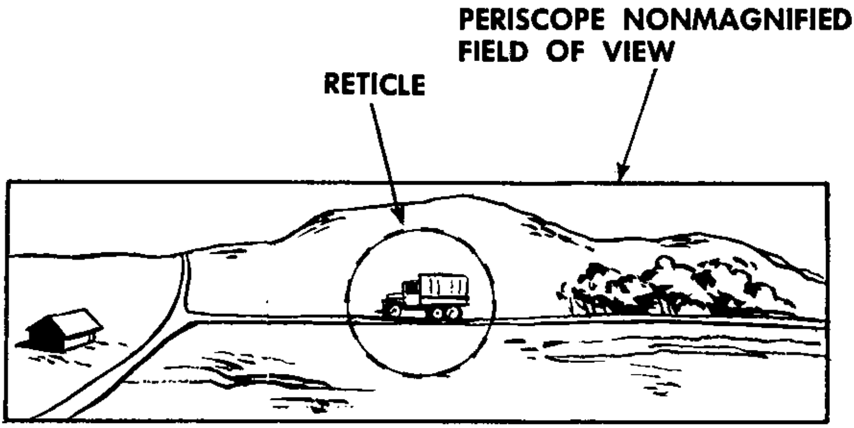


Figure 27. Infinity sight reticle (nonballistic).

b. Filters.

(1) *General.* Filters are colored or polarized transparent disks that are placed in the path of light through the optical system of a fire control instrument to reduce intensity or glare. They may be provided as separate elements for attachment or mounted in such a manner that they can be placed in or out of position by a selectable lever. Not all sighting devices are equipped with filters.

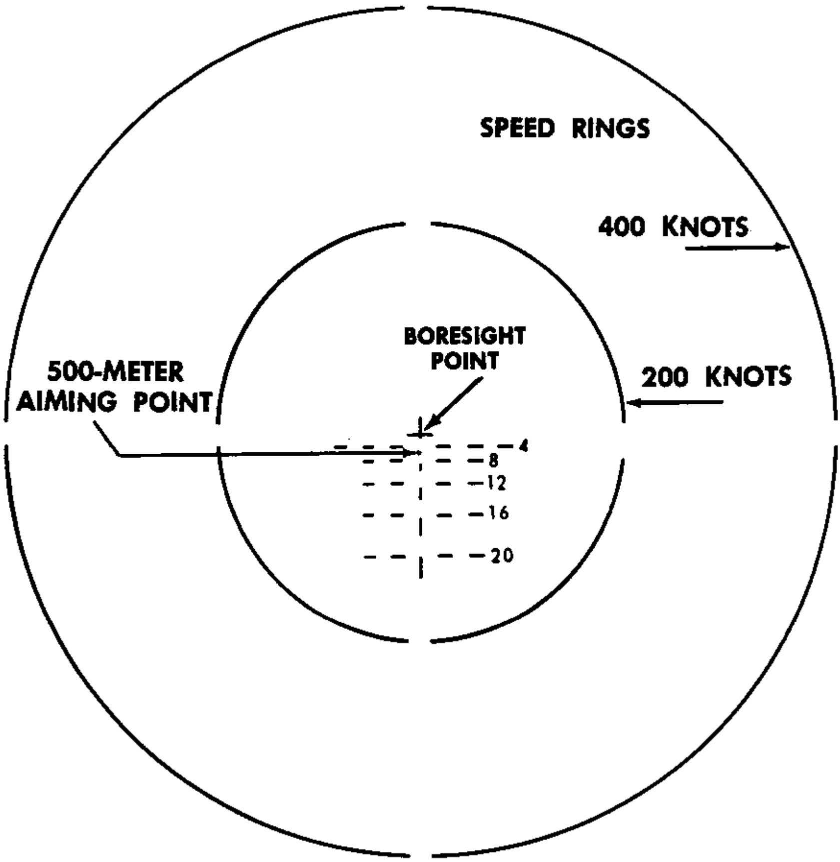


Figure 28. Cupola-mounted periscope reticle (ballistic).

(2) *Colored filters.* Filters of various colors are used to improve visibility under different atmospheric and light conditions.

(*a*) *Smoke* (*neutral*) *filter*—Greatly reduces the intensity of light and is used to lay on enemy searchlights or targets that are silhouetted by or in close vicinity of the sun.

(*b*) *Yellow and amber filter*—Employed to reduce the reflection of sunlight on water or snow or other general conditions of glare.

(*c*) *Amber and red filter*—Employed under various conditions of fog and ground haze.

(*d*) *Blue filter*—Aids in detecting the outlines of camouflaged objects.

(*e*) *Greenish-yellow filter*—Serves the purpose of both smoke and amber filters.

(3) *Polarizing filters.* These types do not change the color

of objects but merely decrease light intensity. When mounted in pairs, they can be used to provide continuous control of light intensity.

c. Coated Optics.

(1) *General.* Whenever light strikes an ordinary glass surface, most of the light is transmitted through the glass and undergoes refraction. However, under even the most favorable conditions, about 4 to 6 percent of the light is lost by reflection from each optical surface. Coating reduces the loss of light from each surface to about one percent, resulting in a corresponding increase in the amount of light transmitted through the element. Optical elements so treated are termed coated optics. In tank gunnery all sights with magnification have coated optics.

(2) *Maintenance of coated optics.* The coating is durable enough to permit handling during assembly and disassembly and to withstand careful cleaning, but if the sights are not handled and cleaned properly, the coating will be scratched or removed, with a resultant loss of efficiency in the sight. Only authorized cleaning materials will be used, and even then with care.

50. Direct Laying

Direct laying takes place when tank gun targets are observed and aimed at through the direct-fire sights. To lay the gun on a target, the gunner uses the power or manual controls to traverse and elevate or depress the gun until the proper point of the sight reticle is laid on the target (par. 110).

Section V. SIGHT ADJUSTMENT

51. General

Guns vary in their performance due to inherent differences such as wear, jump, and droop. The range scales used in fire control equipment are based on standard range table angles of elevation and make no allowance for the varying characteristics of individual weapons. To compensate for the variation in performance, sights must be adjusted. This adjustment must be accomplished periodically, as the movement of the tank and firing of the tank gun may cause sights to move out of adjustment. Accurate sight adjustment is fundamental in tank gunnery; it is impossible to fire accurately without it. Sight adjustment includes boresighting, zeroing, and verification and refinement of the zero.

Note. For boresighting and zeroing procedures for subcaliber firing, see paragraph 254.

52. Boresighting

Boresighting provides the basis for all sight adjustment. It is performed to establish a definite relationship between the axes of the guns and the direct-fire sights, and is accomplished to facilitate zeroing or the indexing of an established zero. Complete boresighting, performed daily before firing, includes boresighting the main gun, coaxial machinegun, cupola-mounted machinegun, and coaxially mounted searchlight. To boresight, position the tank as level as possible, to eliminate or reduce cant error (par. 58), and proceed as follows:

a. Main Gun.

(1) Select a target with a clearly defined right angle. Range to the target should be as indicated in the technical manual for the tank.

(2) Affix thread across the marks on the muzzle of the gun to form a cross. This cross is used as the front sight.

(3) Open the breechblock and insert the breech boresight (if available). If no breech boresight is available, use the firing pin well as a rear sight.

(4) Place the range finder (if tank is so equipped) in operation and index the range to the target on the range scale. This is necessary to properly aline the auxiliary reticle for deflection even though superelevation is subsequently removed from the fire control system.

(5) Remove all superelevation from the sights by use of the computer or ballistic unit.

(6) Using the front and rear sights on the gun ((2) and (3) above), aline the axis of the bore on the target (aiming point) by *manually* elevating and traversing the gun. Use the right telescope of the binocular to sight through the gun tube (fig. 29).

(7) Without disturbing the alinement of the gun, unlock the boresight knobs of all sights for the main gun and turn the knobs to move the aiming crosses or boresight crosses of all reticles to the aiming point (fig. 29). Relock the boresight knobs.

(8) Slip the numbered scales on the boresight knobs in order to establish a known point from which to make corrections. The normal setting to which the scales are slipped is established for the standard boresight range in the field (or technical) manual for the tank.

(9) Recheck to insure that the gun and boresight points of all direct-fire sights are on the correct boresight point.

Note. As a target may not be available at the standard boresighting range, some slip scales have reference marks for boresighting at other ranges. These alternate settings correspond to various ranges and are etched on the slip scale in red. After boresighting at a range other than the standard boresight range, the scale should be slipped to the corresponding red number. For example, if a boresight range of 600 meters is used, the scales must be slipped to the red 6. (For slip scale settings, see the appropriate technical manual.) After slipping the scales to the appropriate red mark, index the established zero or emergency zero by unlocking the boresight knobs and turning them to the appropriate reading; then relock the knobs. The red reference marks apply to boresighting when the standard range is not used and they are not used in zeroing.

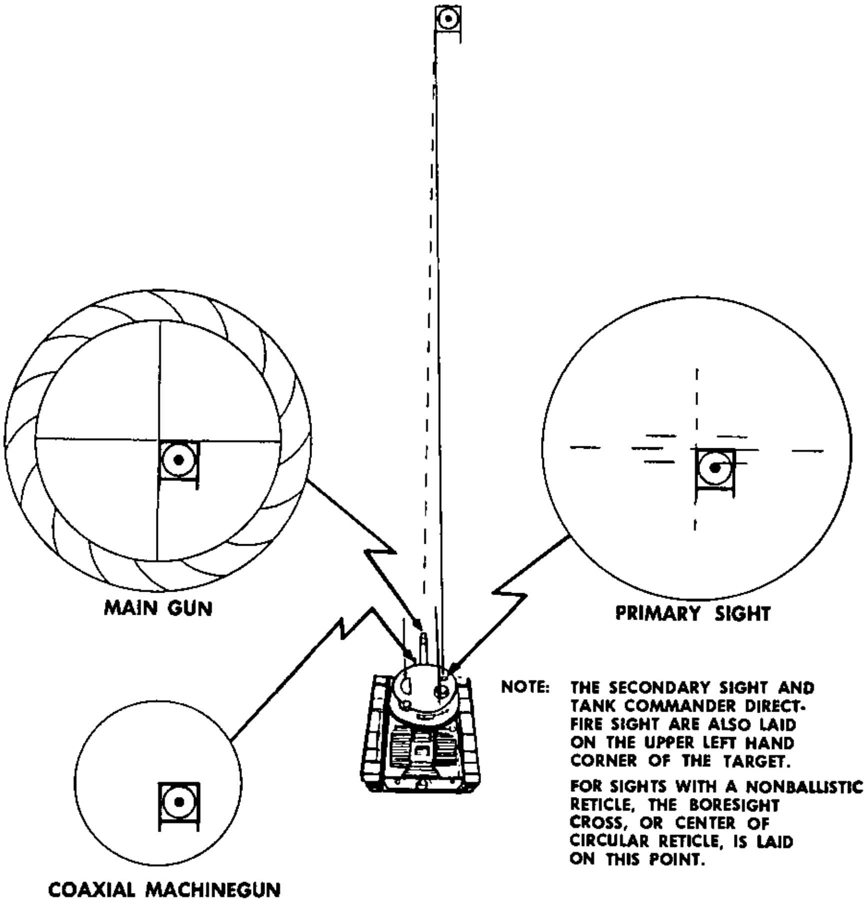


Figure 29. Boresighting the main gun and coaxial machinegun.

b. Coaxial Machinegun.

Note. Boresighting the coaxial machinegun takes place immediately after boresighting the main gun.

(1) Select a target at the same range used for the main gun (normally the same target or aiming point).

(2) With all superelevation removed from the fire control system, lay the aiming cross of the primary sight on the aiming point by use of the gun controls. Then if a separate sight is available for the coaxial machinegun, move this sight to the aiming point by use of its boresight knobs.

(3) Remove the back plate and bolt or receiver group from the machinegun.

(4) Looking through the barrel, move the axis of the barrel to the same aiming point by using the adjusting mechanisms on the machinegun mount.

(5) Make a final check to insure that the sights and machinegun are on the aiming point and then replace the bolt and back plate or receiver group.

c. Cupola-Mounted Machinegun.

(1) Select a target with a clearly defined right angle at a range of 500 meters (yards).

(2) Remove the back plate group and the bolt from the machinegun.

Note. On the M85 caliber .50 machinegun, hold the feed cam lever to the left to allow a clear view through the barrel.

(3) With the elevating and traversing controls, aline the axis of the machinegun barrel on the aiming point. Engage the azimuth (travel) lock and use the vernier to make a precise adjustment.

(4) Without moving the machinegun, refer the boresight point of the machinegun sight reticle to the same aiming point.

(5) Replace the bolt and back plate group.

d. Tank-Mounted Searchlight. Boresighting the searchlight is alining the axis of the searchlight parallel to the axis of the gun tube. Before such alinement is undertaken, the lamp must be properly focused. Boresighting is accomplished during the hours of darkness or, if done in daylight, by placing the target in a shaded area. To boresight the searchlight, proceed as follows:

(1) Project the beam on a smooth, light-colored, vertical surface, e.g., a 6 x 6-foot panel target. The target should be approximately 60 meters from the tank.

Note. Place two black dots approximately 2 inches in diameter on the target. Space the dots vertically with the same distance between the axes of the gun tube and searchlight. On dual-purpose (visible light and infrared light capabilities) searchlights, either light can be used for boresighting.

(2) Insert the breech boresight (if available) into the gun or remove the firing mechanism. Place black thread on the marks of the muzzle of the gun to form a cross.

(3) Sight through the gun tube and, using the gun controls, lay the axis of the gun tube on the lower black dot. By moving the searchlight independently of the gun, place the center of the beam on the upper black dot. When this has been accomplished the searchlight is boresighted.

53. Emergency Zero

a. After boresighting, if there is no established zero for the main gun, a further correction is applied to sights with a nonballistic reticle on some type tanks, to compensate for the characteristics of the weapon and for drift of the projectile in flight. This correction is an emergency zero. It is applied by unlocking the boresight knobs and turning them to move the sight reticle a specified number of mils in elevation and azimuth. (See the field or technical manual for the tank.) The knobs are then relocked.

Note. If zeroing is to be accomplished following the boresighting procedures, the emergency zero need be applied only to the primary sight, if it is used, and the other sights are then adjusted upon completion of zeroing (par. 54*a*(8)).

b. If there is no established zero for the weapon, firing would take place with the emergency zero or with the boresight setting on sights with no emergency zero. If it is not possible to zero, all nonballistic sights, when applicable, will have the emergency zero applied.

54. Zeroing

Zeroing is the firing of the gun to adjust the sights so that the point of aim and the point of strike of the projectile coincide at a given range, thereby increasing the accuracy of fire at all direct-fire ranges.

a. Main Gun (fig. 30). To zero the main gun, proceed as follows:

(1) Boresight and apply emergency zero (if applicable).

(2) Select a well-defined point in the target area at a range

as indicated in the technical manual for the tank. The boresight target will normally be used.

Note. To give a high probability of all rounds in the shot group striking the target, this should be a 12 x 12-foot target. The target used will have a bulls-eye 8 inches in diameter and a circle of the radius specified in (8) below.

(3) Determine the range to this target by the most accurate means available.

(4) Index the range and type of ammunition to be fired in the fire control system and make a precise lay on the center of the target using the *manual* controls.

(5) Fire one round with the correct sight picture. If the gun is cold, the accuracy of this first round is doubtful; therefore, the first round fired through a cold gun is considered a warming round and is not used in the zeroing procedure. Re-lay on the aiming point and fire another round. (To obtain a correct sensing, re-lay immediately after firing each round.) If the first round fired (other than a warming round) fails to hit the target, note the point on the reticle where the strike of the round appeared in relation to the target and move this point to the center of the target by using the gun controls. Then unlock the boresight knobs, move the aiming cross to the center of the target, and lock the knobs. This procedure provides the gunner with a definite point on the reticle for firing subsequent rounds to establish a shot group. Continue to fire, re-laying on the center of the target by use of the gun controls for each round fired, until there is a three-round shot group. Again re-lay the gun with the sight on the center of the target.

Note. Normally ammunition that can be sensed will be used to zero. However, if the type used cannot be sensed from the tank, position an observer (driver of tank) approximately 10 meters to the windward side of the tank to adjust fire if the first round misses. All zeroing rounds should be of the same type and lot number.

(6) Without disturbing the lay of the gun, move the aiming cross to the center of the shot group using the boresight knobs. Lock the boresight knobs.

(7) Use the manual gun controls to lay the aiming cross back on the aiming point.

(8) Fire a check round. The projectile should strike within *24 inches* of the aiming point at 1,200 meters or *30 inches* at 1,500 yards. If it does not, fire a second check round.

If either round strikes within the specified distance from the aiming point, the gun is zeroed; if not, continue the zeroing procedure until a check round does strike within the specified distance. The aiming cross or appropriate range line of all sight reticles for the main gun are then referred to the aiming point. This is an established zero.

Note. The second check round is not fired if the first check round strikes within the specified distance.

(9) Record the zero settings and place them in some convenient part of the turret. In subsequent sight adjustment, this established zero is applied after boresighting to preclude repeating the zeroing procedure.

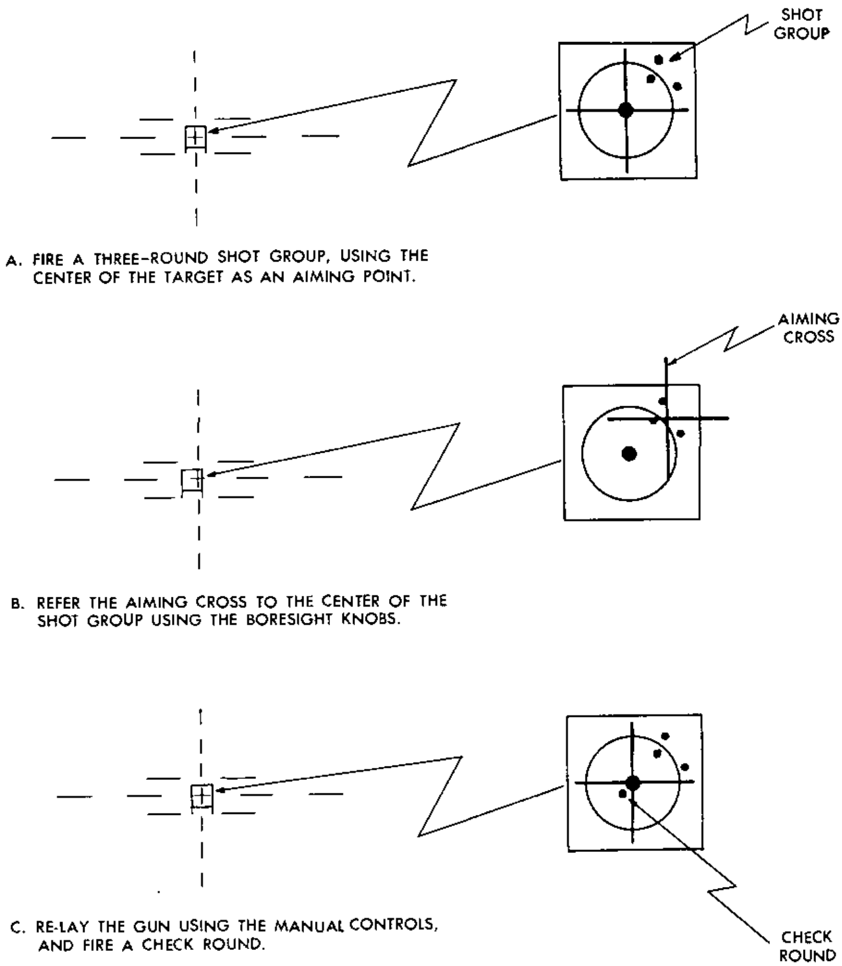


Figure 30. Zeroing the main gun.

b. Zeroing the Coaxial Machinegun. Once boresighted, the coaxial machinegun is zeroed by firing to cause the center of the beaten zone to hit the target at a range of 800 meters (yards). To zero the coaxial machinegun, proceed as follows:

(1) Index the known range to the target in the fire control system.

(2) Index ammunition in the fire control system. If machinegun ammunition cannot be indexed, index the type of ammunition with the lowest muzzle velocity.

(3) Use the coaxial machinegun sight to lay on the aiming point and fire a burst of 20 to 25 rounds. If the coaxial machinegun sight is not available, use the main gun primary direct-fire sight.

(4) Use the adjusting mechanisms on the coaxial mount to adjust the gun so the beaten zone of a subsequent burst of 20 to 25 rounds brackets the target (do no move the sight).

c. Cupola-Mounted Machinegun.

(1) Select a target (normally the boresight target) with a clearly defined aiming point at a range of 500 meters (yards).

(2) With the elevating and traversing controls, lay the 500-meter (-yard) point of the periscope on the aiming point of the zeroing target.

(3) Fire from 3 to 5 rounds, 1 at a time. Check the lay of the gun after each shot and re-lay if necessary.

(4) Without disturbing the lay of the gun, move the 500-meter (-yard) point of the reticle to the center of the shot group.

(5) Fire from 3 to 5 rounds, single shot, to verify the zero. The weapon is zeroed when the center of this shot group is within 18 inches of the aiming point.

55. Verification of an Established Zero

Make periodic checks of the zero by boresighting and indexing the established zero setting, then firing a check round at a definite aiming point at the zeroing range. If the projectile strikes within the prescribed distance of the aiming point, the zero is correct. If the projectile fails to strike within the prescribed distance, refine the zero (par. 56). Repetition of the zeroing exercise is necessary only on replacement of the gun tube.

56. Refinement of an Established Zero

Each gunner should be aware of any constant error that exists in firing the main gun. When such an error is detected, the zero of the gun is refined to obtain greater accuracy. To refine the zero, proceed as follows:

a. Boresight. This is done to insure that errors in firing are not being caused by loss of boresight.

b. Fire a two-round shot group at a zeroing target or any vertical surface at the zeroing range indicated in the technical manual for the tank.

c. With the same sight picture used to hit the target, unlock the boresight knobs and turn them until the aiming cross is in the center of the two-round group. This refinement results in a new established zero.

57. Tactical Zeroing

In combat, if a zeroing panel is not available, a building, sign, or similar target may be selected and the tank gun zeroed by normal methods. When no target is available that would show a shot group, the following procedure is used:

a. Select a terrain feature as near the zeroing range for the tank as possible. Use the most accurate means available to determine this range.

b. Boresight and apply the established zero. If there is no established zero, use the emergency zero or the boresight setting.

c. Lay on the center of the selected target and fire one round.

d. Note the point on the reticle where this round strikes in relation to the target and, using the gun controls, move that point to the center of the target.

e. Using the boresight knobs of the sight, move the aiming cross to the center of the target. This provides a definite point on the reticle for firing subsequent rounds.

f. Fire a check round.

g. Continue to adjust the sights until the round strikes within approximately 24 inches of the aiming point.

58. Effects of Drift, Cant, and Parallax

Drift, cant, and parallax cause a certain amount of error in firing. These errors are usually small at direct-fire ranges and can be corrected somewhat by zeroing and adjusting fire.

a. Drift is the deviation of the projectile from the plane of fire. It is the result of the effects of rotation and air resistance on the projectile. The rotation imparted to spin-stabilized projectiles by

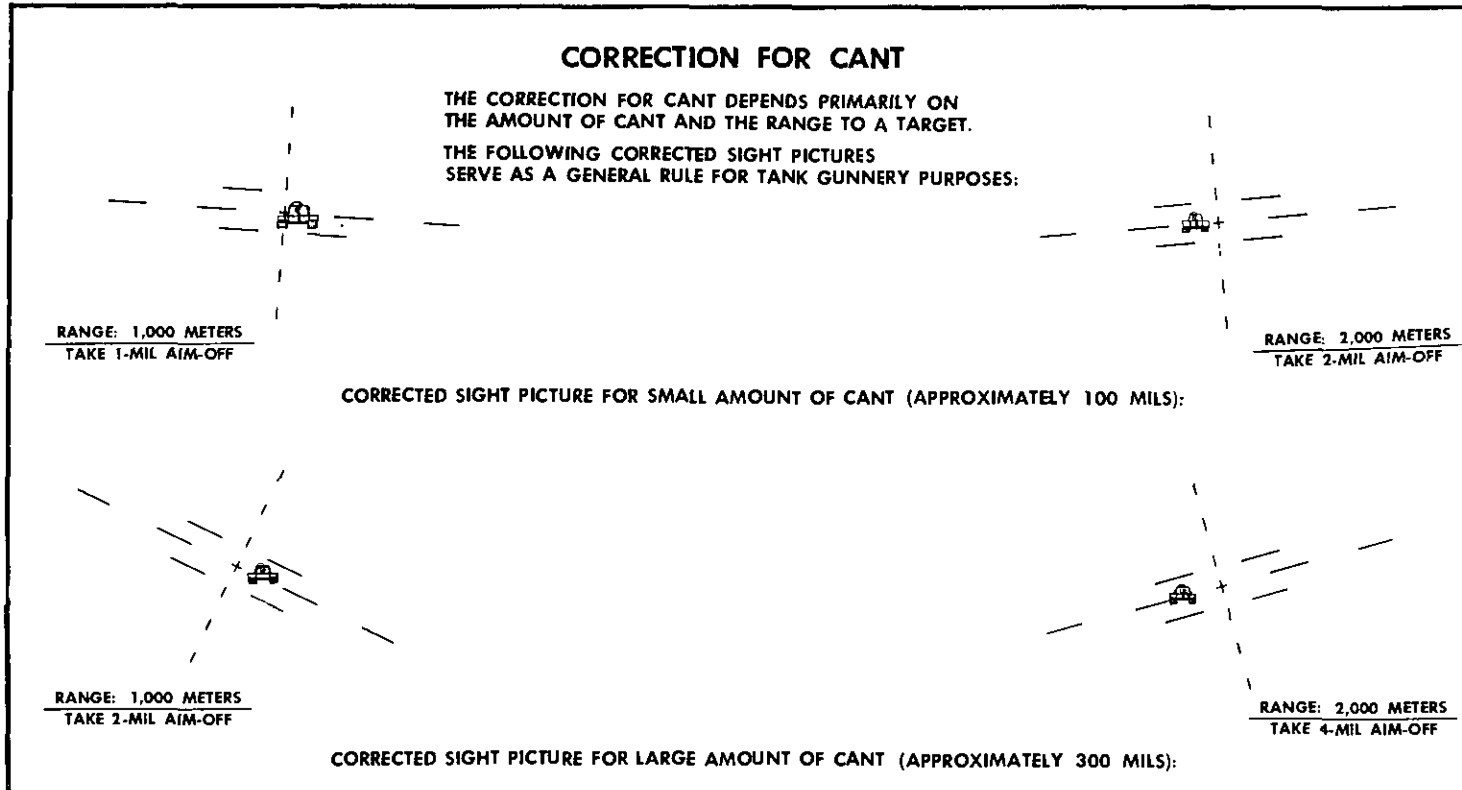


Figure 31. Corrected sight pictures for cant.

the rifling of the bore causes the projectiles to drift in the direction of the rotation. This drift is to the right, since all tank gun bores are rifled with a right-hand twist. Ballistic reticles correct for drift by use of offset range lines; however, nonballistic reticles do not. Proper zeroing results in full compensation for drift at the zeroing range and partial compensation at other direct-fire ranges. When firing at long ranges is conducted, as indirect fire, data from firing tables can be used to compensate for drift.

b. Cant is the inclination of the gun trunnions (trunnion tilt) from the horizontal when the ground is not level. As the range to the target increases, cant causes increasing deflection and range error in the direction in which the tank is canted. Cant is avoided by the selection of as level a firing position as possible. When cant is unavoidable, error can be compensated for by taking a corrected sight picture (fig. 31) for the initial round.

c. Parallax is the apparent difference in the position of an object when it is viewed from two different points. A parallax error is caused by the sights being offset from the gun tube. This error can be corrected at the zeroing range and is of small consequence at any direct-fire range. A parallax error is caused also by not positioning the eye to the sight in the same manner for each sight picture. This is corrected through gunnery training and proper adjustment of the headrest.

Section VI. TANK-MOUNTED AUXILIARY FIRE CONTROL EQUIPMENT

59. General

Auxiliary fire control instruments are used to lay the gun when the target cannot be engaged by use of the direct-fire sights. These instruments include quadrants and azimuth indicators.

60. Quadrants

Quadrants are used to measure gun elevation angles. They may be mounted on the ballistic drive or gun mount, or carried in a case and, when they are to be used, set on the breech ring. Whatever the type, all quadrants have an elevation scale and index for coarse adjustment, a micrometer scale and index for fine adjustment, and a leveling vial to indicate the horizontal (fig. 32). All measurements are taken from the horizontal; therefore, the elevation scale and micrometer scale must be used in conjunction with the leveling vial. Quadrants must be checked periodically to determine their accuracy, and if inaccurate they must be adjusted or turned into Ordnance for repair.

61. Azimuth Indicator

a. The azimuth indicator (fig. 33) is used to lay the gun for direction and to measure horizontal angles. It is mounted so that its gear meshes with the turret ring gear and is located on the right side of the turret where it can be viewed by the gunner. The azimuth indicator has three scales: an azimuth scale graduated in 100-mil increments, a micrometer scale graduated in 1-mil increments, and a gunner's aid scale graduated in 1-mil increments. There are three pointers: an azimuth pointer (middle) and a micrometer pointer pointer (outer), both of which are adjustable, and a directional pointer (inner). The directional pointer indicates the amount of turret traverse measured from the front center of the tank and is nonadjustable. To use the azimuth indicator, lay the gun on a reference point by use of the direct-fire

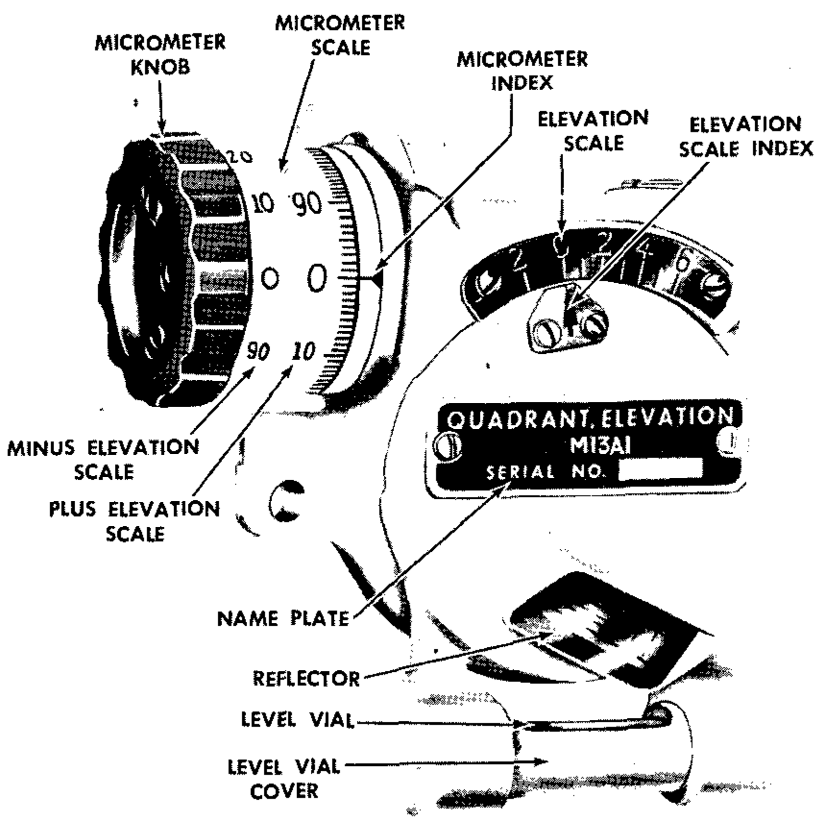
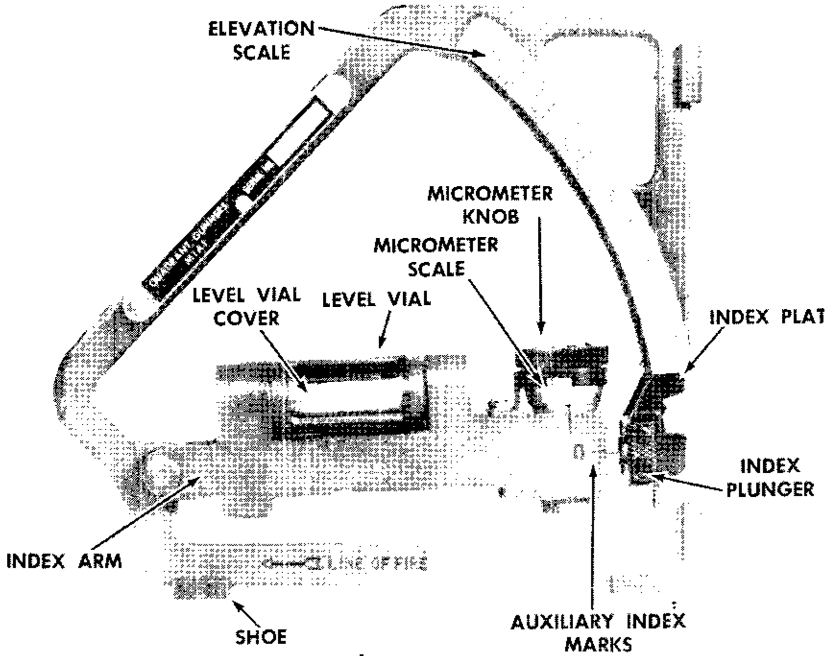


Figure 32. Two types of quadrants.



GUNNER'S QUADRANT

Figure 32—Continued.

sights. Push down on the resetter knob and rotate it to move the azimuth and micrometer pointers to zero, then release it. Any subsequent turret rotation will be measured by the azimuth and micrometer scales. For small shifts (50 mils or less) in deflection, rotate the gunner's aid to index the zero of its scale opposite the micrometer pointer, then traverse the turret in the desired direction until the micrometer pointer indicates the required deflection angle on the gunner's aid.

b. Azimuth indicators must be checked periodically for accuracy (see appropriate technical manual for the tank). As no error is allowable, inaccurate instruments must be repaired by Ordnance.

62. Indirect Laying

Indirect laying is used when the tank gun is fired at targets that cannot be observed through the direct-fire sights.

a. To lay the gun for elevation, determine the elevation for range using a firing table, ballistic unit, or computer. Combine the elevation for range with the angle of site to the target (pars. 66*d* and 171). The result is the quadrant elevation required to hit the target. Index the quadrant elevation on the quadrant,

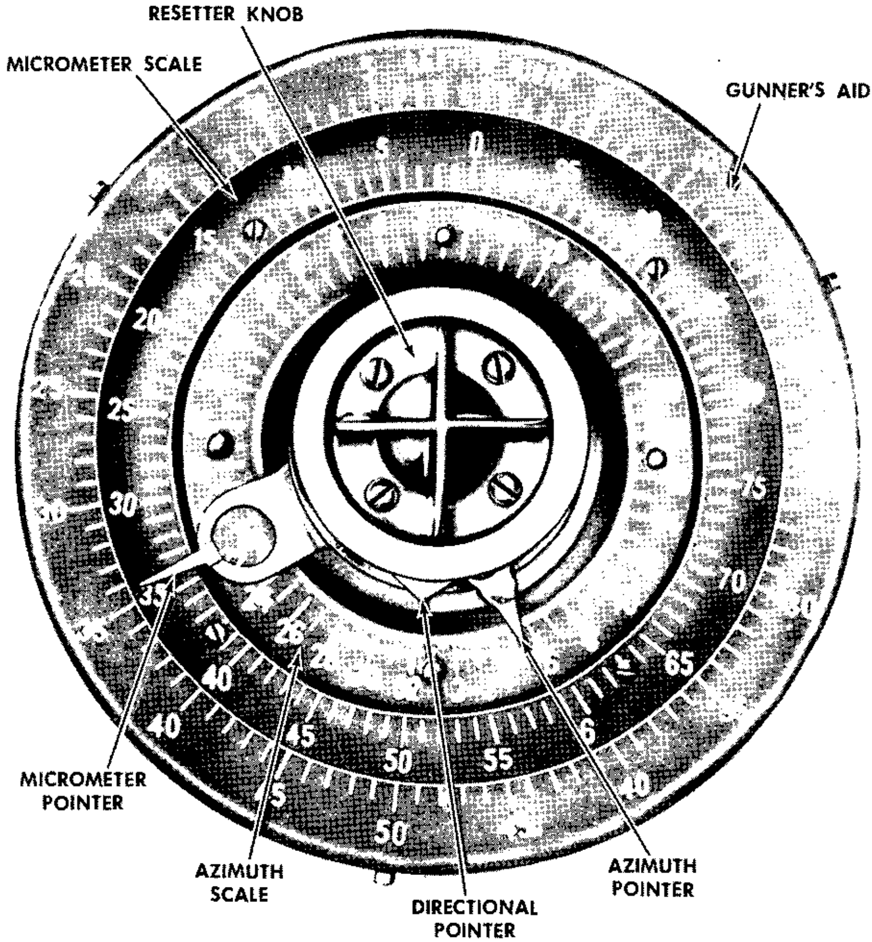


Figure 33. Azimuth indicator.

using the elevation and micrometer scales. For example, to lay the gun on a quadrant elevation of plus 135 mils, index plus 100 mils on the elevation scale and plus 35 on the micrometer scale. Then elevate or depress the gun until the bubble in the leveling vial is centered. Apply subsequent elevation corrections by adding or subtracting the number of mils to or from the initial elevation, setting the result on the elevation and micrometer scales, and elevating or depressing the gun until the bubble in the leveling vial is centered. If a subsequent elevation correction is given as a new quadrant elevation, apply this setting to the elevation and micrometer scales and move the gun until the bubble is centered.

b. Before the gun is laid for deflection, the azimuth indicator must have been zoomed on a reference point. To lay the gun for deflection, traverse the turret until the correct deflector reading is shown on the azimuth and micrometer scales of the azimuth indicator. Traversing the gun to the right moves the pointers clockwise; traversing to the left moves the pointers counterclockwise. After initially laying the gun for deflection, place the zero of the gunner's aid opposite the micrometer pointer. Subsequent deflection shifts of 50 mils or less can then be made with reference to the zero of the gunner's aid (except when a new deflection has been announced). Do not set the micrometer pointer back to zero after each unit shift; instead, move the zero of the gunner's aid to a position opposite the pointer. To make subsequent shifts greater than 50 mils, add or subtract the subsequent shift to or from the initial deflection, and traverse until the azimuth and micrometer pointers indicate the correct reading.

Section VII. AIMING CIRCLE

63. General

The aiming circle is an auxiliary fire control instrument for measuring horizontal angles (including magnetic and grid azimuths) and vertical angles (including angles of site) and for general survey work. In tank gunnery, the aiming circle is used to lay tank guns parallel and to prepare firing data.

64. Description of Aiming Circle

The M2 aiming circle (figs. 34, 35, and 36) has four main parts; telescope assembly, compass assembly, azimuth mechanism, and leveling assembly. Accessory equipment includes a tripod, a black plate and canvas cover, an instrument light, a plumb bob assembly, a lamp holder and remover, and a cover for the aiming circle.

a. Telescope Assembly. This assembly consists of a 4-power, fixed-focus instrument with a leveling device. The telescope is pivoted above the compass assembly and may be moved through a vertical angle of minus 400 mils to plus 800 mils, by turning the telescope elevating knob. The elevation scale is graduated every 100 mils from minus 4 to plus 8. The elevation micrometer scale is graduated in 1-mil increments from 0 to 100 and is numbered every 10 mils. The telescope has a reticle (fig. 37) with vertical and horizontal mil scales; these scales are graduated in 5-mil increments, 85 mils in each direction from the center. The reticle can be illuminated for night use by inserting the lamp bracket assembly of the instrument light in the dove tail slot of the telescope.

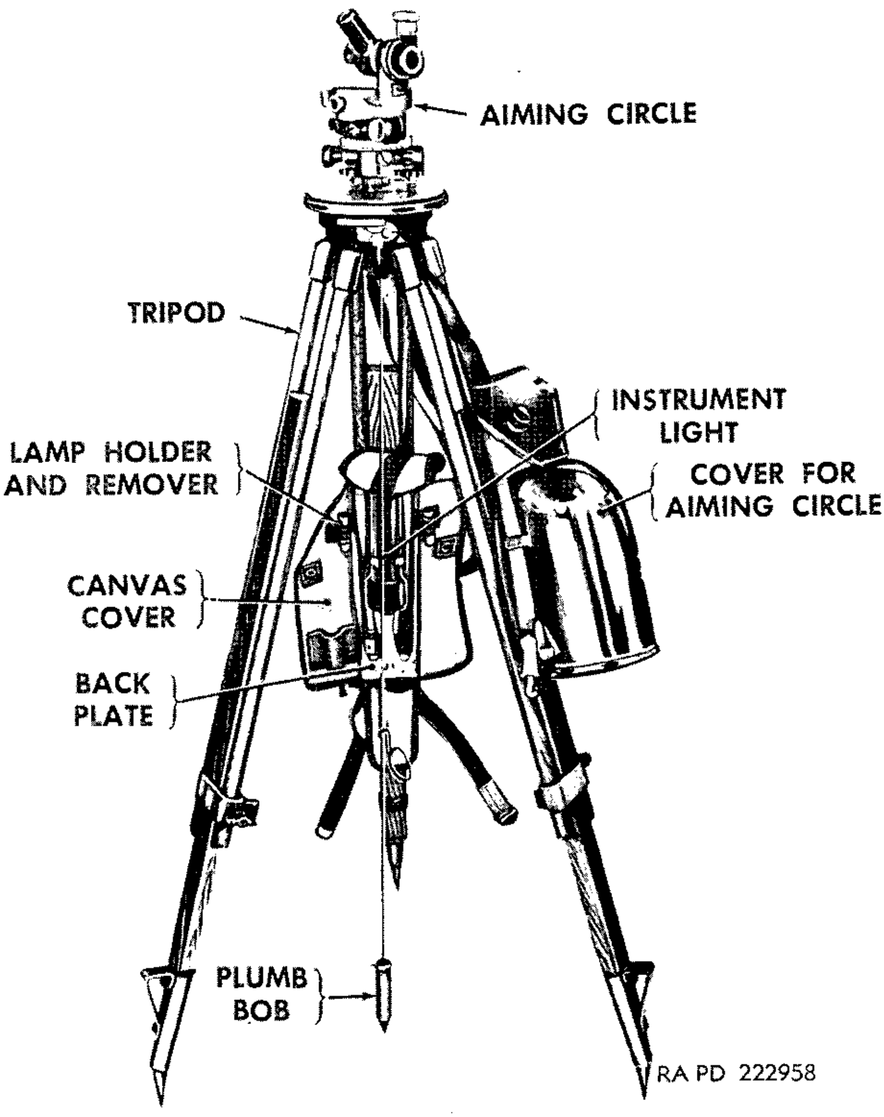


Figure 34. Aiming Circle, M2, with equipment.

b. Compass Assembly. The magnetic compass is located in the oblong recess in the top of the compass housing. A rectangular glass reticle is located at one end of the compass recess. A 10-power magnifier, set in the wall of the housing, enables the observer to aline the end of the compass needle with the line of the reticle. Using the hand light of the instrument light assembly, the operator can introduce light through the glass window closest

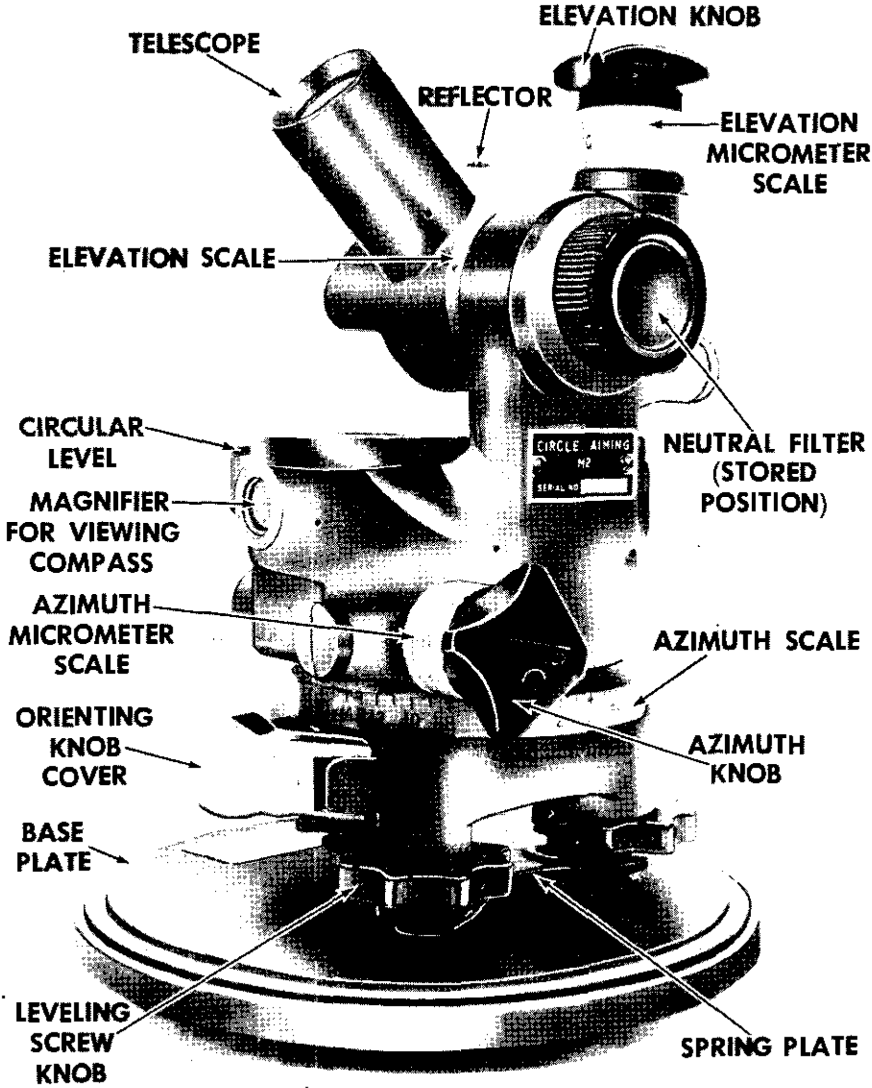


Figure 35. Aiming Circle, M2—right side view.

to the magnifier in top of the compass assembly to enable him to see the needle more clearly.

c. Azimuth Mechanism. The azimuth mechanism has an azimuth micrometer scale and an azimuth scale. The azimuth scale has two scales that are graduated at 100-mil intervals and numbered every 200 mils. The upper scale is graduated clockwise from 0 to 6,400. The lower scale, graduated clockwise from 0 to 3,200, parallels the 3,200–6,400 upper graduations. The azimuth micrometer scale is located on the azimuth knob. It is graduated in mils and is numbered every 10 mils from 0 to 100. The azimuth

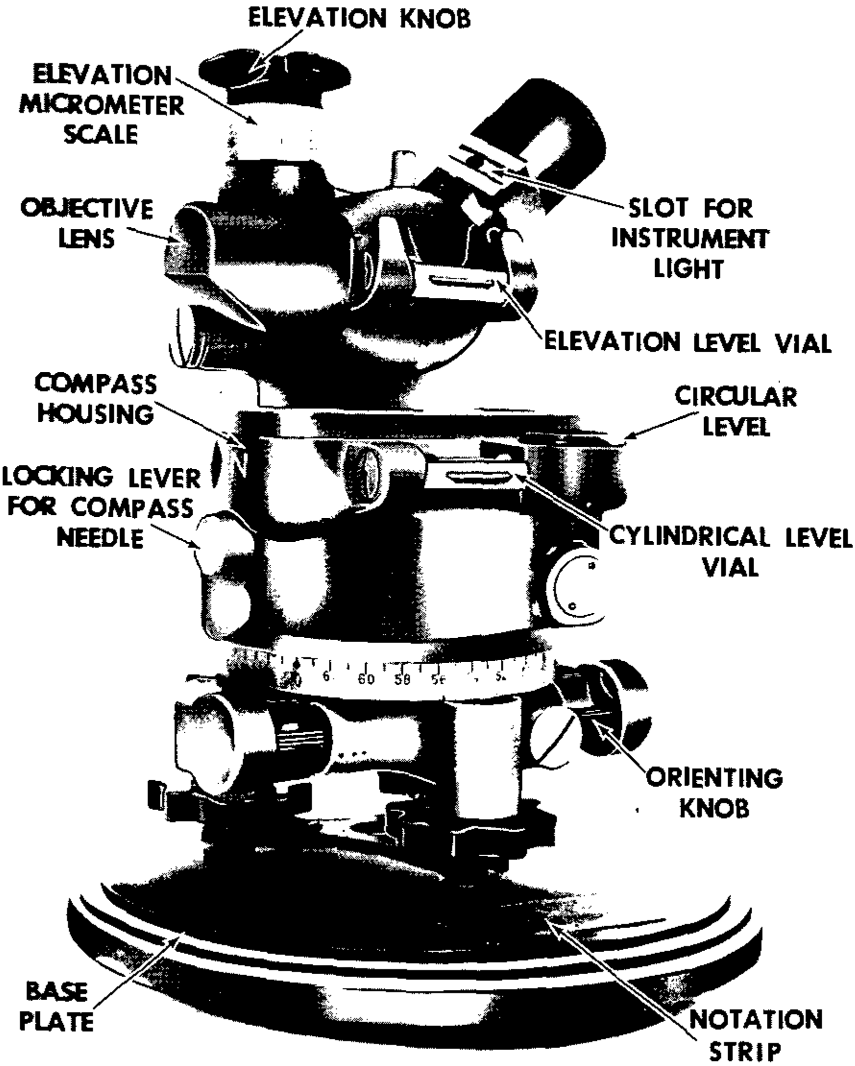


Figure 36. Aiming Circle, M2—left side view.

knob (slow upper or recording motion) is used for fine adjustments by turning; disengage for use as a throwout lever for fast upper motion. Two orienting knobs control the slow lower, or nonrecording, motion by turning either; disengage for use as a throwout lever for fast lower motion.

d. Leveling Assembly. The leveling assembly is provided for horizontal leveling of the instrument. It consists of a base plate and three leveling screws.

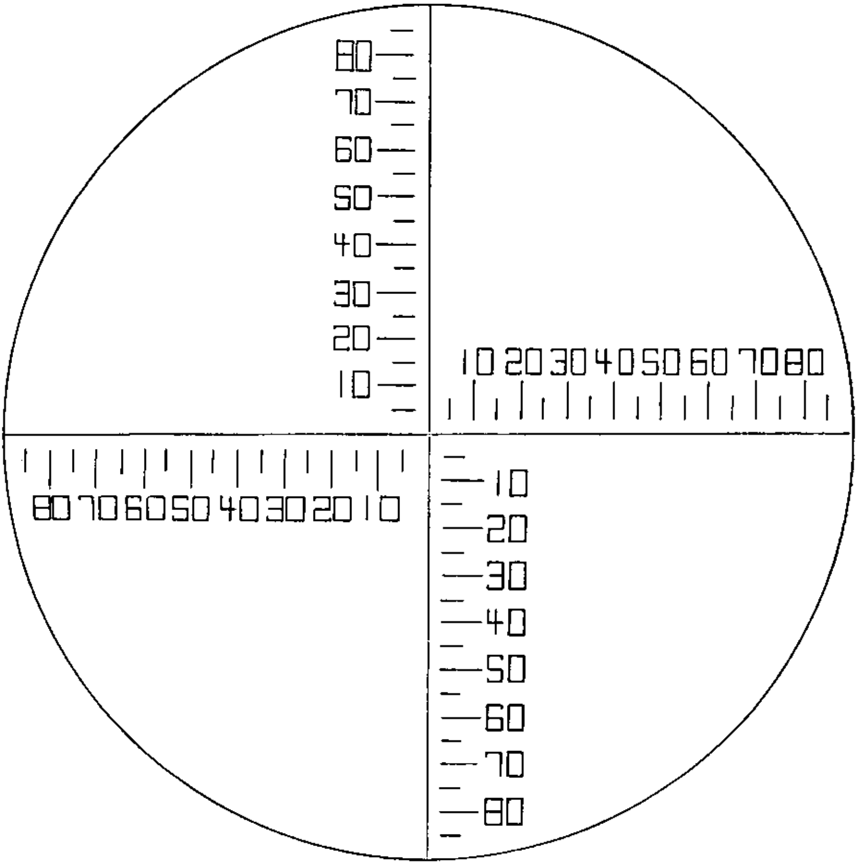


Figure 37. Telescope reticle, Aiming Circle, M2.

65. Operation of Aiming Circle

a. Setting Up the Aiming Circle.

(1) Unstrap the tripod legs. Loosen the leg clamp thumbscrews and extend the lower legs to the desired length. Tighten the thumbscrews and bed each leg firmly in the ground. Unscrew the tripod head cover.

(2) Open the base plate cover assembly and thread the tripod screw into the aiming circle until it is firmly seated. Unsnap the aiming circle cover latches; remove the cover. Check the circular level on the aiming circle and readjust the tripod legs until the level is approximately centered.

(3) If the instrument is to be oriented with respect to a particular point, remove the plumb bob assembly from the canvas cover and hang it on the tripod hook. Adjust

the position of the tripod legs until the plumb bob hangs directly over the point, keeping the circular level approximately centered.

(4) Turn the aiming circle leveling screws until the circular level bubble is centered. Then rotate the aiming circle to insure that the bubble remains centered throughout 6,400 mils of traverse.

(5) With the aiming circle in a level position, turn the elevation scale and elevation micrometer scales to zero. Note the position of the bubble in the level attached to the telescope body; it should be centered. If it is not, center the bubble using the telescope elevation knob. Loosen the screws that hold the knob and without changing the level position of the bubble, slip the elevation micrometer scale to zero. Tighten the knob screws and check to insure that the elevation level bubble is level with the micrometer scale zeroed.

Note. The cylindrical level on the compass assembly is not used in tank gunnery. Its purpose is for accurate leveling of the instrument; in tank gunnery this degree of accuracy is not required.

b. Objects Affecting the Operation of Compass Assembly. The compass needle will not orient on magnetic north when the instrument is too close to metallic objects or to wires conducting electricity. Metallic objects such as steel helmets, small arms, and binoculars should be moved away from the instrument. For proper operation when the compass assembly is used, the aiming circle should be set up at least the distances shown from the following objects:

High-tension power lines	150 meters
Tanks or other armored vehicles	75 meters
Trucks or telegraph wires	40 meters
Barbed wire, steel helmets, small arms, etc.	10 meters

66. General Uses of Aiming Circles

a. General. To use the aiming circle properly, it is necessary to know the following definitions and procedures:

(1) Magnetic north is the direction indicated by the magnetic needle of a compass.

(2) Grid north is the north direction of the grid line on a map or gridded chart.

(3) Azimuth is a horizontal angle measured clockwise from north.

(*a*) Grid azimuth is the clockwise angle from grid north to a definite point.

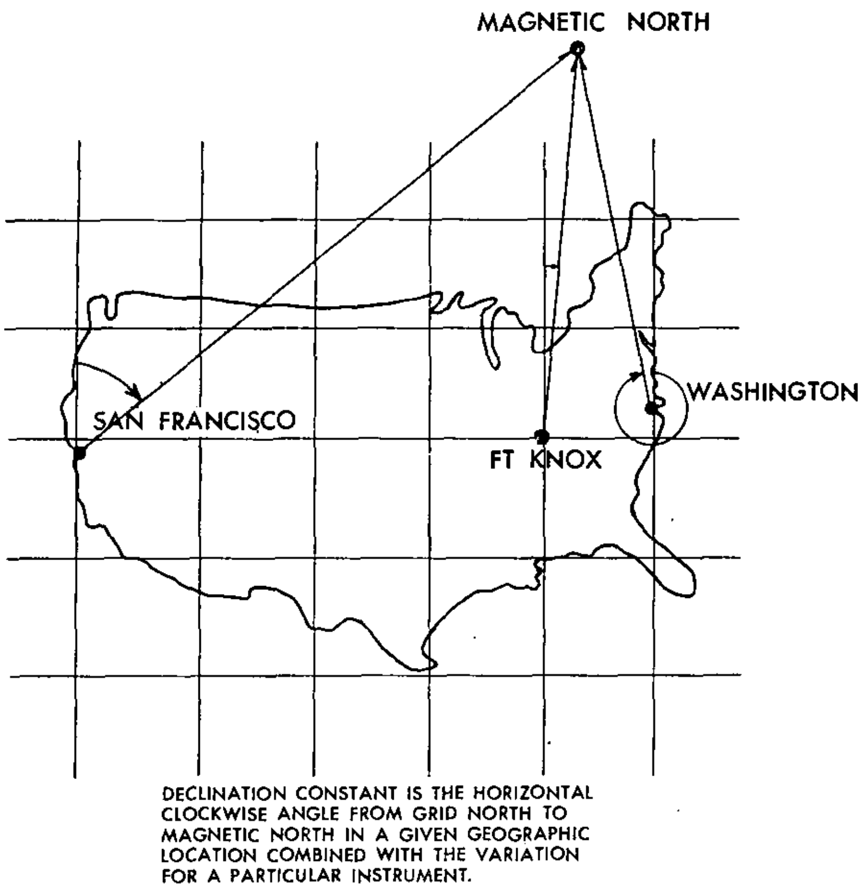


Figure 38. Declination constant.

(*b*) Magnetic azimuth is the clockwise angle from magnetic north to a definite point.

(4) Declination constant (fig. 38) is the horizontal clockwise angle from grid north to magnetic north of a particular instrument; this will vary for different localities and for different instruments. The declination constant, therefore, is a combination of the grid-magnetic angle and variation of the instrument.

Note. Variation of instruments is caused by tolerances allowed in manufacturing the aiming circle and by wear of the moving parts. Variation does not affect accurate operation of the instrument when it has been properly declinated.

(*a*) To declinate an instrument is to determine the declination constant of the instrument (par. 68).

(*b*) To convert magnetic azimuths to grid azimuths, the declination constant must be applied to the compass reading.

b. Measuring Horizontal Angles.

(1) Set up and level the base plate of the aiming circle.

(2) Zero the azimuth and micrometer scales.

(3) Using the fast lower motion and the open sight on the telescope assembly, turn the instrument in the general direction of the point from which the angle is being measured.

(4) Sight through the telescope. Using the slow lower motion, place the intersection of the horizontal and vertical lines of the reticle on the point from which the angle is being measured. (To eliminate lost motion, always make the last movement of the vertical line in the same direction.)

(5) Using the upper motion, place the vertical line of the reticle on the point to which the angle is being measured.

(6) Read the azimuth and micrometer scales. This reading is the angle between the points.

c. Measuring Vertical Angles.

(1) *Vertical angles using telescope reticle.*

(*a*) Level the instrument.

(*b*) Lay the intersection of the horizontal and vertical lines of the reticle on the point from which the angle is being measured.

(*c*) Read the angle to the other point by use of the vertical scale.

(2) *Vertical angles using elevation scale.*

(*a*) Level the instrument.

(*b*) Turn the telescope elevating knob until the horizontal line of the reticle is on the point from which the angle is being measured; record the reading.

(*c*) Turn the elevating knob until the horizontal line is on the point to which the angle is being measured; record the reading.

(*d*) If both readings are plus or both minus, subtract, and the difference is the vertical angle. If one reading is plus and the other minus, add the two readings to get the vertical angle.

d. Measuring Angles of Site.

(1) Level the instrument.

(2) Lay the vertical line in the telescope reticle on the point to which the angle of site is being measured.

(3) Level the telescope by centering the bubble in the tele-

scope assembly. Check to insure that the elevation micrometer scale is zeroed.

(4) Turn the telescope elevating knob until the horizontal line is on the point.

(5) Read the angle of site from the elevation and micrometer scales. If the reading is plus, the angle of site is plus; if the reading is minus, the angle of site is minus.

e. Measuring Magnetic Azimuths.

(1) Level the instrument.

(2) Zero the azimuth and micrometer scales.

(3) Unlock the compass needle.

(4) Look through the compass needle magnifier and use the lower motion to aline the center vertical line of the reticle with the compass needle.

(5) Lock the compass needle.

(6) Look through the telescope and use the upper motion to place the intersection of the horizontal and vertical lines on the point to which the azimuth is being measured.

(7) Read the magnetic azimuth from the azimuth and micrometer scales.

f. Measuring Grid Azimuth.

(1) Level the instrument.

(2) Index the declination constant on the azimuth and micrometer scales.

(3) Unlock the compass needle and center it, using the lower motion.

(4) Lock the compass needle.

(5) Look through the telescope and use the upper motion to place the intersection of the horizontal and vertical lines on the point to which the grid azimuth is being measured.

(6) Read the grid azimuth from the azimuth and micrometer scales.

67. Laying Tank Guns Parallel

When indirect fire is employed, tank guns are laid parallel; that is, regardless of the position of the tank hulls, all gun tubes are parallel. The purpose of this procedure is to insure fire coverage of the target area and to allow control of the fire of all tanks by a single command (par. 169). Tankers may use any 1 of 3 methods to lay tank guns parallel.

a. Tanks and Target or Reference Point Visible. When the tanks and the target area are both visible to the aiming circle operator, the following procedure may be used (fig. 39):

(1) The operator levels the aiming circle and zeroes the azimuth and micrometer scales. Using the lower motion, he sights on the target, a point in the target area, or a reference point in line with the firing position and target. He then commands AIMING POINT THIS INSTRUMENT, DIRECTION OF FIRE . . . (points).

(2) Each gunner sights through his telescopic sight (using the boresight cross) on the telescope reflector or center of the aiming circle and sets his azimuth indicator at zero. The tank commander then announces NUMBER (ONE) READY.

Note. The hand light can be used to illuminate the reflector to aid gunners in laying.

(3) Using the upper motion, the operator lays the vertical line of the telescope reticle on the center of the telescope port of tank No. 1.

(4) The operator reads the azimuth and micrometer scales and announces the reading: For example, NUMBER ONE, DEFLECTION ONE THREE FOUR ZERO. (If necessary, the reading must be taken from the lower scale so that it will always be less than 3,200 mils.) The process is repeated for each tank.

(5) The tank commander commands DEFLECTION ONE THREE FOUR ZERO RIGHT (LEFT) and the gunner traverses his turret until the azimuth indicator reading is the same as the announced deflection.

Note. This is announced so that the aiming circle operator also can hear the command and announce a correction if it was repeated erroneously.

When each tank crew has completed this procedure, the tank guns are laid parallel. Since the azimuth indicator is graduated into two 0–3,200 parts, the gunner must know the direction of fire so that he can use the appropriate part of the scale.

(6) Gunners now zero their azimuth indicators and aiming stakes are set out for each tank (par. 77).

b. On Grid Azimuth. Tank guns are laid parallel on a grid azimuth as follows:

(1) The aiming circle operator subtracts the grid azimuth from the declination constant of the instrument (6,400 mils is added to the declination constant if the grid azimuth is larger than the declination constant).

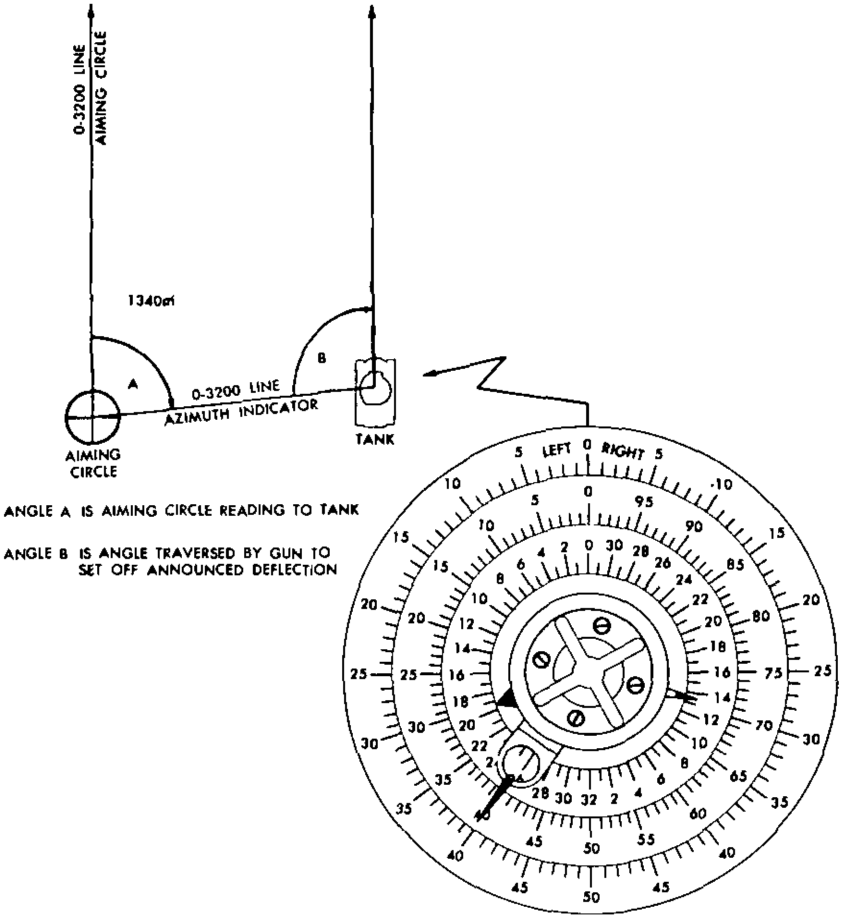


Figure 39. Laying tank guns parallel when both tanks and target are visible to aiming circle operator.

(2) With the instrument level, the operator indexes the result on the azimuth and micrometer scales. Using the lower motion, he centers the compass needle. (The 0–3,200 line of the aiming circle is now pointing along the given grid azimuth.)

(3) The operator then commands AIMING POINT THIS INSTRUMENT, DIRECTION OF FIRE . . . (points). Tank guns are then laid parallel by following the procedure in *a*(2) through (6) above.

Note. If ordered to lay tank guns parallel on a magnetic azimuth, convert this azimuth to a grid azimuth by use of a map and follow the procedure in (1) through (3) above.

c. Reciprocal Laying. If an aiming circle is not available, tank guns may be laid parallel by reciprocal laying (fig. 40), as follows:

(1) The gunner of the center tank alines his telescope in the direction of the target by laying on some object or terrain feature that is in line with the target (as determined by a map study or by laying on aiming stakes that have been placed in line with the target by use of a map and compass). The gunner then zeroes his azimuth indicator.

(2) The commander of the center tank commands NUMBER TWO, LAY ON ME, and the gunners of the center tank and the tank on the immediate right then traverse until both telescopic sights are alined on each other.

(3) The commander of the center tank points in the direction of fire and announces his azimuth indicator reading: For example, the commander points in the direction of fire and announces NUMBER TWO, DEFLECTION ONE THREE FOUR ZERO.

(4) The tank commander of the right tank repeats the command and includes the direction of fire (right or left).

Note. This is announced so that the tank commander who originated the deflection can also hear the command and announce a correction if it was repeated erroneously.

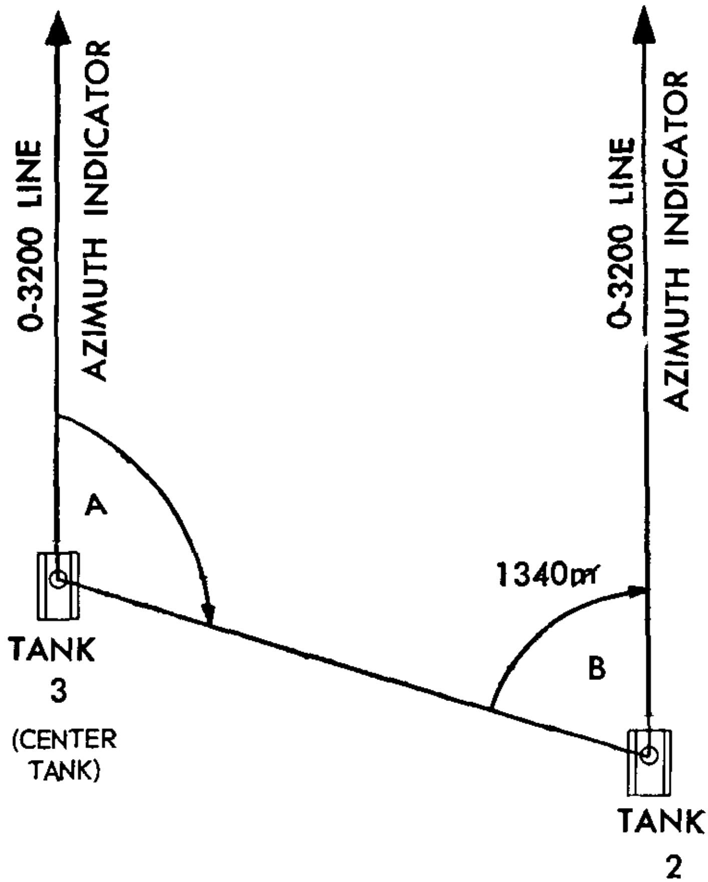
The gunner of the right tank indexes the announced reading on the azimuth indicator, using the scale opposite the direction of fire. For example, if the gun must be traversed right to move toward the direction of fire, then the left half of the azimuth scale is used. He then traverses in the prescribed direction until zero is indicated on the azimuth indicator. The gun of the right tank is now parallel to the direction of fire.

(5) The crew of the center tank repeats the process to lay the gun of the left tank. The tanks thus laid then lay tanks on their flank in the same manner.

68. Declinating Aiming Circle

The aiming circle should be declinated within 30 days of the time of use and within 25 miles of the place of use. To declinate an aiming circle, a declinating station or point must first be established, normally by an artillery or engineer unit, by use of a transit. In the absence of an established declinating station, an instrument can be declinated for a particular locality on any line of known grid azimuth. After the line of known azimuth has been determined, the aiming circle is declinated as follows:

a. Set up the aiming circle over one end of the line of known azimuth (which serves as a declinating station) and level the in-



ANGLE A IS AZIMUTH INDICATOR READING TO TANK 2.

ANGLE B IS MOVEMENT IN DIRECTION OF FIRE TO AZIMUTH INDICATOR READING OF ZERO AFTER SETTING THE ANNOUNCED DEFLECTION ON SCALE OPPOSITE DIRECTION OF FIRE.

Figure 40. Reciprocal laying.

strument carefully. Exact orientation over the grid point requires using the plumb bob.

b. Zero the azimuth and micrometer scales and center the compass needle with the lower motion.

c. Using the upper motion, turn to the point of known grid azimuth and record the reading.

d. Repeat this process three times. Then subtract the average of these three magnetic azimuths from the known grid azimuth. (Add 6,400 mils to the known grid azimuth if the magnetic azimuth is greater.) The result is the declination constant for the instrument in that area.

e. Accuracy is increased by using more than one point of known grid azimuth visible from the declination station. When more than one point is available, take the reading to each point, compute the difference, and use the average as a declination constant. An example of this procedure is illustrated in figure 41. The grid azimuth to point A is known to be 682 mils; the magnetic azimuth to point A is measured as 675 mils. Therefore, the difference between the grid azimuth and magnetic azimuth to point A is 7 mils. The grid azimuth to point B is known to be 2,136 mils, while the magnetic azimuth is measured as 2,130 mils, a difference of 6 mils. The grid azimuth to point C is known to be 5,418 mils, and the magnetic azimuth is measured as 5,410 mils; the difference here is 8 mils. The average difference is 7 mils (7 plus 6 plus 8 divided by 3), which is the declination constant of that aiming circle in that area.

f. Record the declination constant on the notation strip of the instrument (fig. 36).

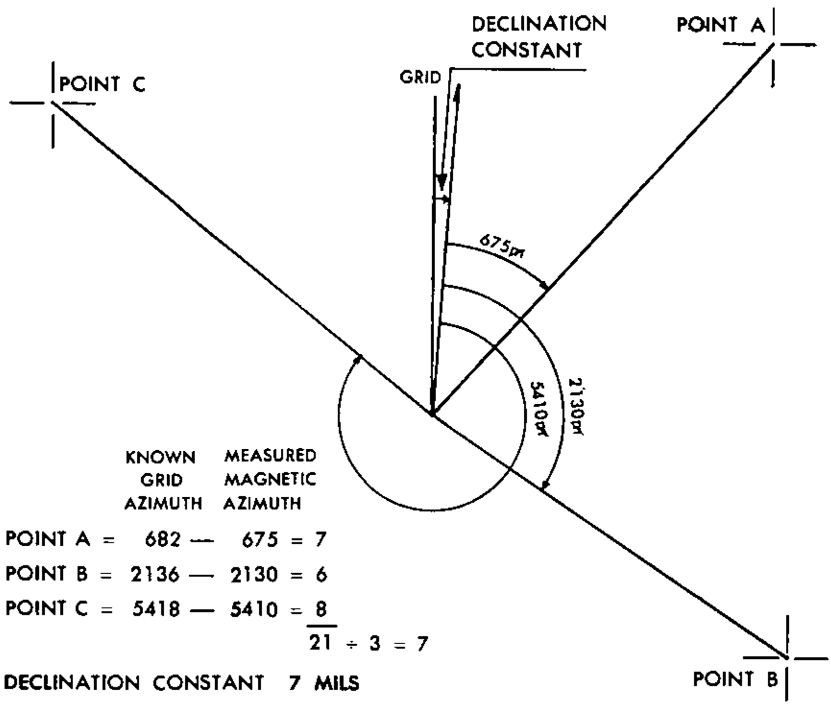


Figure 41. Declinating the aiming circle.

69. Care and Maintenance of Aiming Circle

a. Care.

(1) When the compass needle is not being used, lock it in place.

(2) Stops are provided on the instrument to limit the travel of the moving parts. Do not attempt to force the rotation of any knob beyond its stop limit.

(3) Keep the instrument as clean and dry as possible and covered when not in use.

(4) To protect the optical elements of the aiming circle from the rays of the sun when it is not being used, cover the instrument or place the filter on the objective lens of the telescope. This is the only use of this filter in tank gunnery.

(5) To prevent excessive wear of threads and other damage to the instrument, do not tighten leveling, adjusting, and clamping screws beyond a snug contact.

b. Maintenance.

(1) Under normal operating conditions, clean the exposed metal surfaces of the tripod, and coat them with a thin preservative oil.

(2) Use only authorized lens cleaning materials.

(3) Only Ordnance personnel are authorized to disassemble and repair the aiming circle.

(4) Inspection and maintenance procedures for the aiming circle are listed in TM 9–6166.

Section VIII. COMPASS

70. General

The M2 compass (figs. 42 and 43) is used to determine azimuth or angle of site. The following are the principal parts of this compass:

a. Compass body assembly.

b. Angle of site mechanism.

c. Magnetic needle and lifting mechanism.

d. Azimuth scale and adjuster.

e. Front and rear sights.

71. Description of Compass

a. Compass Body Assembly.

(1) In the compass body, a circular glass window covers and protects the compass needle and angle of site mechanism.

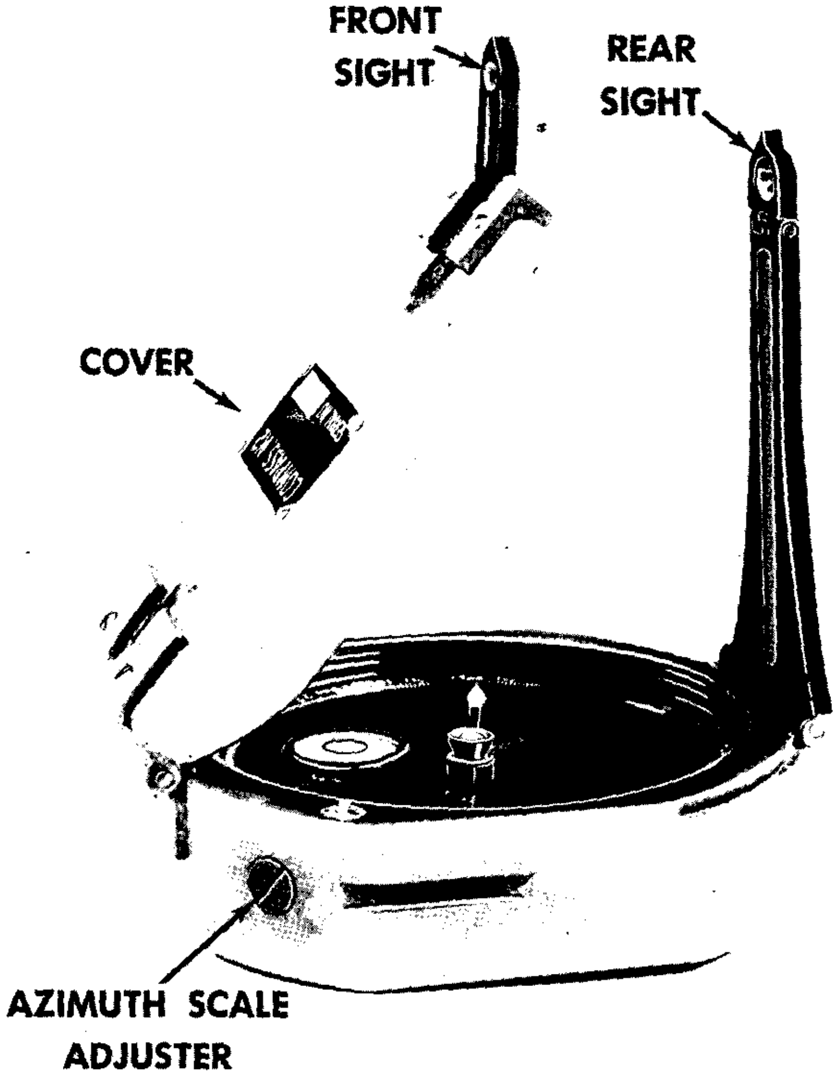


Figure 42. Compass, M2—side view.

(2) A hinge assembly keeps the compass cover parallel with the body when opened. A hole in the cover coincides with a small oval window in the mirror on the inside of the cover. A sighting line is etched across the face of the mirror.

b. Angle of Site Mechanism.

(1) The angle of site mechanism is attached to the bottom of the compass body. It consists of an actuating lever, located on the back of the compass body, and a leveling assembly with a tubular elevation level and a circular level. The instrument is leveled with the circular level

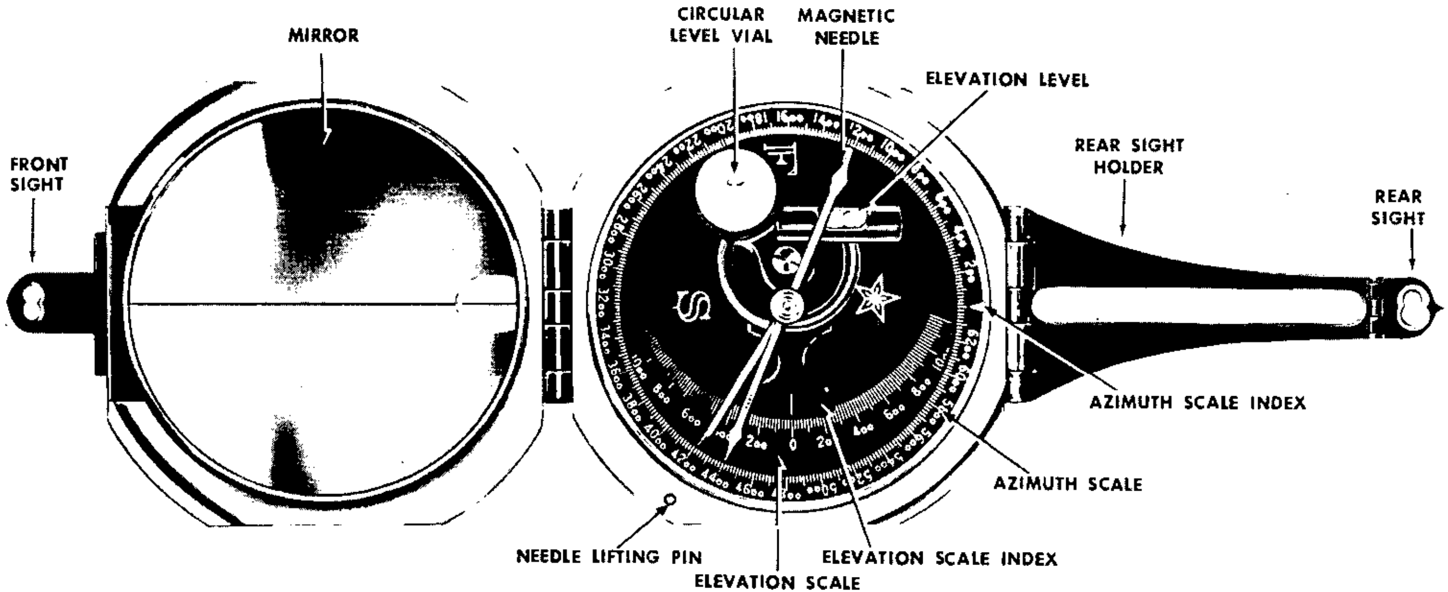


Figure 43. Compass, M2—top view.

to read azimuth and with the elevation level to read angles of site.

(2) The elevation (angle of site) scale and the four points of the compass, represented by three letters and a star, are engraved on the inside bottom of the compass body. The letters E and W are reserved to facilitate reading direction through the mirror. The elevation scale is graduated in two directions; in each direction it is graduated from 0 to 1,200 mils in 20-mil increments and is numbered every 200 mils.

c. Magnetic Needle and Lifting Mechanism.

(1) The magnetic needle assembly consists of a magnetized needle and a jewel housing, which acts as a pivot. The north-seeking end of the needle is painted white and the south end is painted black. A thin piece of copper wire is wrapped around some needles to act as a counterbalance.

(2) A lifting pin projects slightly above the top rim of the compass body. The lower end of the pin engages the needle-lifting lever. When the cover is closed, the magnetic needle is automatically lifted from its pivot and held firmly against the window of the compass.

d. Azimuth Scale and Adjuster.

(1) The azimuth scale is a circular dial geared to the azimuth scale adjuster. This permits the azimuth scale to be rotated approximately 900 mils in either direction. The azimuth index, a small metal pin, provides a reference point for orienting the azimuth scale to the magnetic declination.

(2) The azimuth scale is graduated clockwise in 20-mil increments, from 0 to 6,400, and is numbered at 200-mil intervals.

e. Front and Rear Sights. The front sight is hinged to the compass cover so that it can be folded into its bracket when not in use. The rear sight is made in two parts, a rear sight and a holder. When the compass is not being used, the rear sight is folded across the compass body and the cover is closed.

f. Carrying Case. This case fits the general contour of the M2 compass. A loop on the back of the case permits its attachment to the user's belt.

72. Uses of Compass

The M2 compass is an auxiliary fire control instrument for measuring horizontal angles (including magnetic and grid azimuths) and vertical angles (including angles of site).

a. Measuring Horizontal Angles.

(1) Using the compass sights, sight on the left extremity of the angle to be measured and note the reading on the azimuth scale.

(2) Sight on the right extremity of the angle to be measured and note the reading on the azimuth scale.

(3) Subtract the first reading from the second (adding 6,400 if necessary) ; the difference is the horizontal angle.

b. Measuring Magnetic Azimuths.

(1) Zero the azimuth scale by turning the azimuth scale adjuster.

(2) Level the instrument. For very precise measurements place the instrument on a post, nonmetallic stake, or similar object and center the bubble in the circular level.

(3) Looking through the sights, sight on the object.

(4) Read the azimuth under the black end of the magnetic needle. (Reading the white end of the needle would give the back azimuth.) Use interpolation to determine angles of less than 20 mils. (When holding the compass in the hands, adjust the cover until the azimuth scale and the magnetic needle can be seen in the mirror.)

c. Measuring Grid Azimuths.

(1) Index the known declination constant on the azimuth scale by rotating the azimuth scale adjuster.

Note. To declinate the compass, follow the general procedure outlined in paragraph 68.

(2) Measure the azimuth as described in *b* above.

d. Measuring Angles of Site.

(1) Open the cover approximately 45° so that, when sighting through the rear sight and the aperture in the cover, you can see in the mirror the bubble in the elevation level. Turn the compass on its left side (with the elevation scale down).

(2). Sight on the point whose angle of site is to be measured.

(3) Rotate the actuating lever (located on the back of the compass body) until the bubble in the elevation level is centered.

(4) Read the angle on the elevation scale opposite the index mark.

e. Measuring Vertical Angles. To measure vertical angles, use the procedure in *d* above, to get 2 readings, 1 at each of the points between which the vertical angle is to be measured. The difference between these readings is the vertical angle between the points.

73. Care and Maintenance of Compass

a. Keep the compass in the carrying case when not in use. After using it in wet weather, wipe it dry before returning it to the carrying case. When the instrument is moved from one position to another or is not is use, the compass cover should be closed; this lifts the needle off its pivot and prevents injury to the pivot or jewel. Be careful not to bend the sights or the cover hinge. Fold the rear sight so that it lies flat on the compass window before closing the cover; failure to take this precaution might result in a broken compass window.

b. This instrument requires no lubrication. Clean the glass portions with a camel's-hair brush, lens tissue, or liquid lens soap. Clean the metal parts with a clean cloth moistened with drycleaning solvent. Clean leather carrying cases with saddle soap.

c. Only Ordnance personnel are authorized to disassemble and repair the M2 compass.

Section IX. MISCELLANEOUS FIRE CONTROL EQUIPMENT

74. Aiming Data Chart

a. As ballistic-type reticles are calibrated for only one type of ammunition, the gunner must compensate for the difference in trajectory when he uses any type of round other than the one for which the reticle is graduated. This correction can be determined by use of an aiming data chart similar to the one shown in figure 44. This type of chart is found in the tabular firing tables issued to tank units (par. 75) and may be attached to the recoil guard of the main gun for ready reference.

b. If an aiming data chart is not available, a computer or ballistic unit can be used as an aiming data chart as follows:

(1) *Computer*.

(*a*) The gunner indexes the announced type of ammunition in the computer.

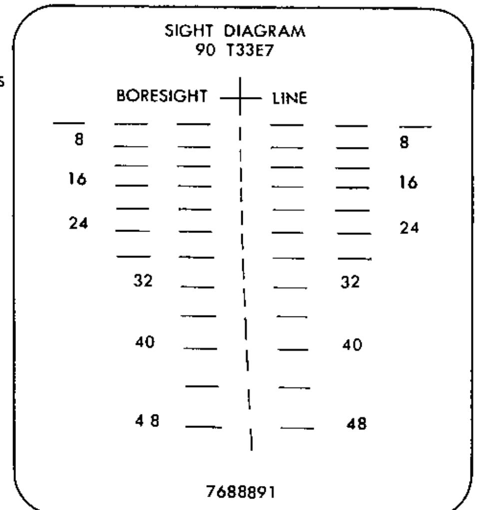
(*b*) With the computer switch *on*, the tank commander ranges or indexes the range to the target on the range scale of the range finder and turns the computer switch *off*. If the input shaft to the computer is inoperative, the gunner must index the range to the target in the computer.

TANK, 90MM GUN, M48 SERIES

W/CANNON M41 AND TELESCOPE M97C

ADC 90-P-1

CART., HVAP-T M332 MODS CART., HVTP-T M333 MODS 3825 F/S	CART., HEAT, T108E46, T108E45 2800 F/S	CART., HEP-T T142E3 2600 F/S	CART., AP-T M318A1 (T33E7) CART., TP-T, M353 (T225) 3000 F S
600	300	300	400
1200	700	600	800
1700	1000	800	1200
2200	1300	1100	1600
2700	1600	1400	2000
3100	1900	1600	2400
3500	2200	1800	2900
3800	2500	2100	3300
4200	2800	2300	3700
4500	3100	2500	4100
4800	3400	2700	4500
5100	3600	2900	5000



CART., HE, M71, CART., WP, M313 2700 F/S	CART., HE-T, T91 2400 F/S	CART., WP-T T92 2400 F/S	CAL. 0.30 MACHINE GUN 2700 F/S	ELEV. MILS
300	300	300	300	2.19
600	500	500	500	4.55
1000	800	800	700	7.07
1300	1000	1000	800	9.77
1700	1300	1300	900	12.65
2000	1600	1600	1000	15.73
2400	1900	1900	1100	19.03
2800	2200	2200	1200	22.57
3200	2400	2500	1300	26.39
3600	2700	2800	1400	30.52
4000	3000	3100	1500	35.00
4400	3300	3400	1600	39.89

TO USE CHART: GET ESTIMATED RANGE AND LOCATE IN COLUMN UNDER AMMUNITION BEING FIRED. READ SIGHT SETTING FROM SIGHT DIAGRAM.

Figure 44. Aiming data chart.

Cartridge, AP-T, M318A1 (T33E7)
Cartridge, TP-T, M353 (T225)

Muzzle Velocity, 3000 f/s

Range	Elevation	Change in Range for 1 mil Change in Elevation	Change in Vertical Height for 100 yds Change in Range	Drift	Time of Flight	Max. Ord.	Range to Max. Ord.	Angle of Fall	Remaining Velocity
yds.	mils.	yds.	ft.	ft.	sec.	ft.	yds.	mils.	f/s
0	0.0	184	0.0	0.0	0.00	0.0	0	0.0	3000
100	0.5	182	0.2	0.0	0.10	0.0	50	0.6	2973
200	1.0	179	0.3	0.0	0.20	0.2	100	1.2	2945
300	1.6	177	0.5	0.0	0.30	0.4	150	1.7	2917
400	2.2	175	0.7	0.1	0.41	0.7	200	2.3	2889
500	2.8	173	0.9	0.1	0.51	1.1	251	2.9	2861
600	3.4	171	1.0	0.1	0.62	1.6	302	3.5	2834
700	4.0	168	1.2	0.2	0.72	2.1	353	4.2	2806
800	4.6	165	1.4	0.3	0.83	2.8	405	4.9	2778
900	5.2	163	1.6	0.3	0.94	3.6	456	5.6	2750
1000	5.8	161	1.8	0.4	1.05	4.5	507	6.3	2722
1100	6.4	159	2.0	0.5	1.16	5.4	559	7.0	2694
1200	7.1	156	2.3	0.6	1.27	6.5	611	7.7	2666
1300	7.7	154	2.5	0.7	1.38	8	664	8.5	2638
1400	8.4	152	2.7	0.9	1.50	9	716	9.2	2610
1500	9.0	150	2.9	1.0	1.61	10	768	10.0	2582
1600	9.7	148	3.2	1.1	1.73	12	821	10.9	2554
1700	10.4	146	3.4	1.3	1.85	14	874	11.8	2526
1800	11.1	144	3.7	1.5	1.97	16	928	12.6	2498
1900	11.8	142	4.0	1.7	2.09	18	981	13.5	2470
2000	12.5	140	4.2	1.9	2.21	20	1034	14.4	2442
2100	13.2	138	4.5	2.1	2.34	22	1088	15.4	2415
2200	13.9	136	4.8	2.3	2.46	24	1142	16.4	2387
2300	14.7	134	5.1	2.5	2.59	27	1197	17.4	2359
2400	15.4	132	5.4	2.8	2.72	30	1251	18.4	2332
2500	16.2	129	5.7	3.1	2.85	33	1305	19.5	2304

Figure 45. Tabular firing table.

(*c*) The gunner indexes in the computer the type of ammunition for which the reticle is graduated. The outer pointer will then indicate the range to be used on the reticle for the type of ammunition to be fired.

(2) *Ballistic unit.*

(*a*) The gunner indexes in the ballistic unit the range to the target on the ammunition scale for which the reticle is graduated.

(*b*) He then determines the corrected range setting by referring to the range indicated by the index for the type of ammunition to be fired.

75. Tabular Firing Tables

Tabular firing tables are printed for each caliber of tank gun (fig. 45). They include data for firing all standard types of ammunition. For description and use, see paragraph 174*b*(2).

76. Graphical Firing Tables

Graphical firing tables are special rules used in the preparation for and conduct of indirect fire. For description and use, see paragraph 174*b*(2).

77. Aiming Stakes

Aiming stakes are used as reference points in indirect fire. They may be constructed from any piece of straight wood or metal pole (approximately 6 to 8 feet in length). They are used in pairs and placed in line with the boresight cross of the telescope approximately 15 to 25 meters for the near one and twice this distance for the far one, positioned so they appear to be one. During darkness or other conditions of poor visibility, a shielded light is taped or tied to the stakes for sighting on the reference point. In tank gunnery, aiming stakes are used in night occupation of a position (par. 154), moving a tank back into position if it has been moved out for fuel, supply, etc., and in realining on a reference point if the azimuth indicator pointers have been inadvertently moved by the resetter knob. Aiming stakes are emplaced for each tank whenever range cards are constructed for a position and whenever tank guns are laid parallel.

CHAPTER 5
RANGE DETERMINATION

Section I. INTRODUCTION

78. General

The greatest potential cause of error in tank gunnery is range determination. When a tank crewman can determine range accurately, the probability of obtaining a first-round target hit is greatly increased.

79. Methods of Determining Range

Methods of determining range are range finders, estimation by eye, binocular and mil relation, maps, intersection, registration, and information from friendly troops. These methods have varying degrees of accuracy. The method used is dependent on the equipment or means available and the threat that the target presents. The best method in any given situation is the one that gives the most accurate range consistent with the time available. When the range finder is available, it is the best means of determining range. As it is not mounted on all tanks or it may become inoperative, tank crewmen must become proficient in all methods of determining range.

Section II. METHODS OF RANGE DETERMINATION

80. Range Finders

On tanks so equipped, the use of the range finder is the primary method of range determination. The value of the range finder lies in the speed and accuracy of determining ranges beyond 1,000 meters (yards). The maximum time required for a trained operator to range on a target is 5 seconds or less. A tank crew can expect first-round hits on visible targets when the range has been determined by a range finder. See paragraphs 253 through 256 for range finder training.

81. Estimation

Estimation is the most rapid but least accurate method of determining range. This method requires a great deal of training. Training must be continuous to maintain the proficiency

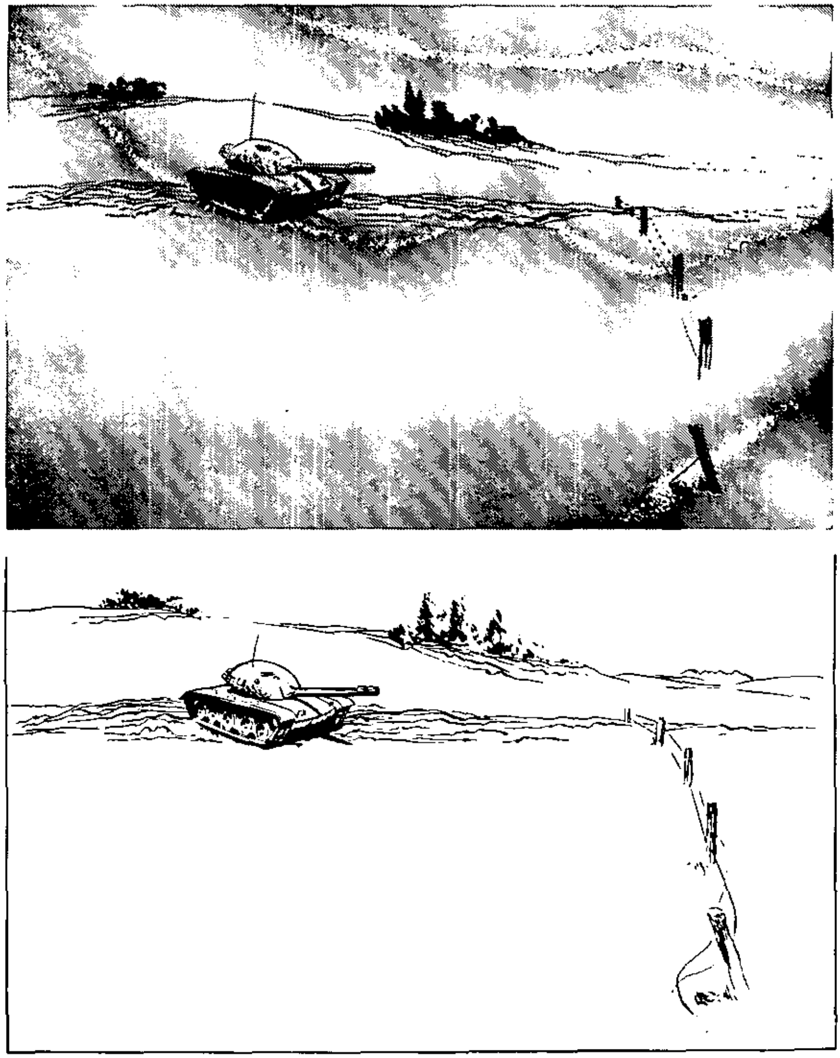


Figure 46. Clarity of outline affects estimation by eye.

necessary to estimate range by eye with any degree of accuracy. Accuracy is also greatly influenced by the distance to the target. As the range to the target increases, accuracy decreases at a rapid rate. In estimating range, the tank crewman employs some form of metal yardstick (pars. 216–219). This yardstick is in multiples of hundreds of meters (yards) to correspond with the graduation on direct-fire sights. However, in order to apply this yardstick with maximum effectiveness, the crewman must be aware of certain factors that influence its application. These factors are nature of the target, nature of the terrain, and light conditions.

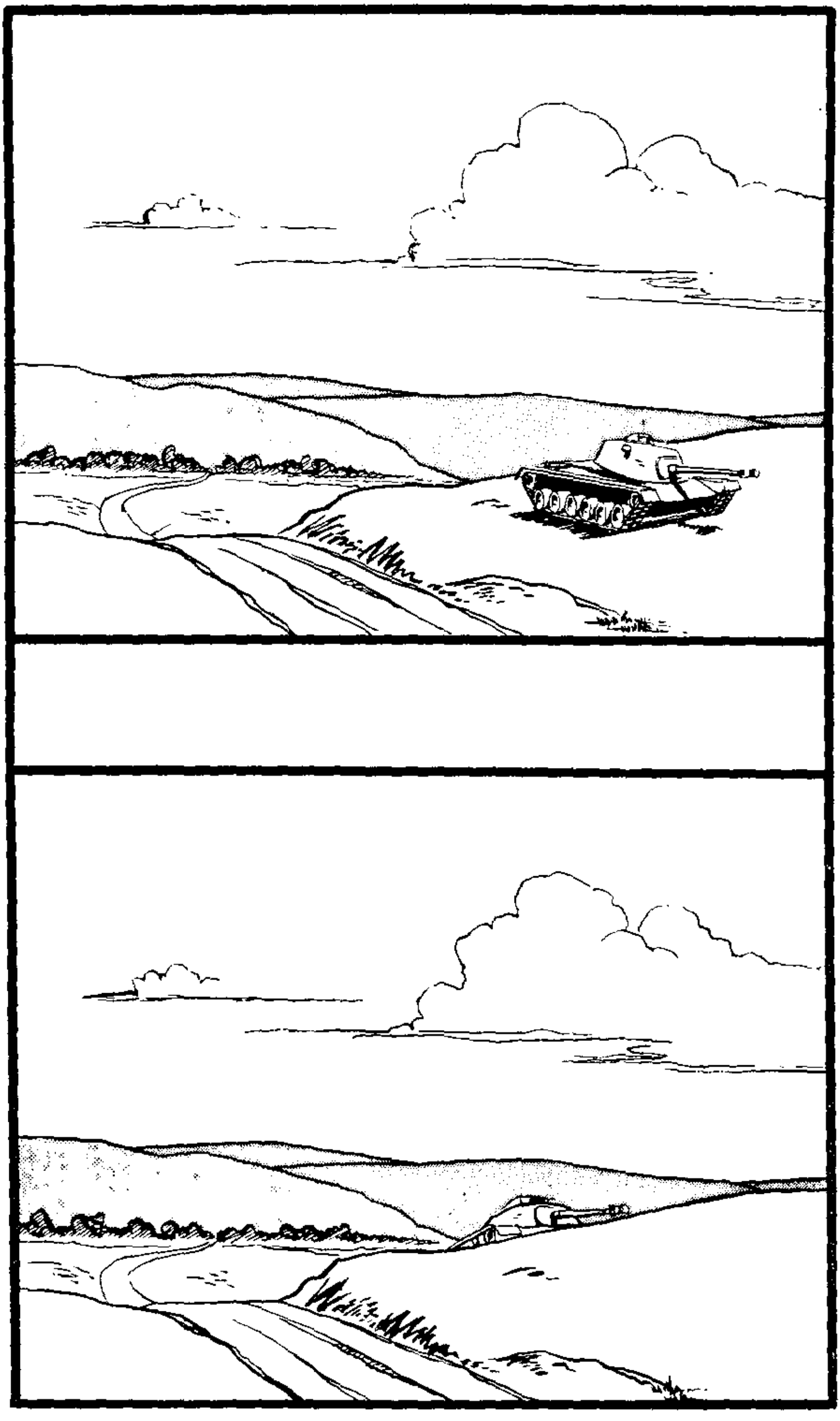


Figure 47. The amount of target visible affects estimation by eye.

As a general rule, the easier target is to see, the closer it appears, and the harder a target is to see, the farther away it appears.

a. Nature of the Target. A target of regular outline, such as a house or vehicle, appears to be closer than it actually is; a target of irregular outline, such as a clump of trees or a camouflaged position, appears to be more distant than it actually is. When the target is in contrast to the background, it appears nearer because the target outline is more clearly defined. If the target blends with the background, it appears farther away because it is more difficult to distinguish the target outline (fig. 46). The amount of target visible also affects the estimate. When the entire target is in view, it appears closer. When only part of the target is visible, it appears to be more distant (fig. 47).

b. Nature of the Terrain. Because projectiles travel through the air from gun to target, the range to be estimated is the air-line distance and not the ground distance. The eye, however, tends to measure the ground distance. In the field, the observer's eye unconsciously tends to follow the irregularities that vegetation and terrain conformation give to the ground line, thus resulting in overestimation of the range. Conversely, in observing over smooth terrain such as desert, water, or snow, or in any other situation where there is little to distract the eye, the tendency is to underestimate the range.

c. Light Conditions. The more clearly a target can be seen, the closer it appears. A target seen in the full light of the sun appears to be closer than the same target seen at dusk or dawn or through smoke, fog, or rain. The position of the sun with relation to the target also affects the apparent range. When the sun is behind the viewer, the target is in full light and easy to see and thus appears to be closer than it actually is. However, when the sun is behind the target and the viewer is looking into the sun, the target is more difficult to see and appears to be farther away.

82. Binocular and Mil Relation

The binocular and mil relation (pars. 38 and 42) are useful in deliberate range determination. The accuracy of this method depends on knowledge of target dimensions and the ability of the individual to make precise measurements of the mil angle. The mil relation may be used in constructing a range determination chart as illustrated in figure 48.

83. Maps

When a tank commander has located the positions of both his tank and the target on a map, he can measure the distance between

MIL ANGLE MEASUREMENT		1	2	3	4	5	6	7	8	9	10
Aggressor medium tank	Length: 6.5 meters	6500	3300	2200	1600	1300	1100	900	800	700	700
	Width: 3.5 meters	3500	1800	1200	900	700	600	500	400	400	400
Aggressor heavy tank	Length: 7.5 meters	7500	3800	2500	1900	1500	1300	1100	900	800	800
	Width: 3.5 meters	3500	1800	1200	900	700	600	500	400	400	400

Notes. 1. The above chart, which facilitates use of the mil relation as a means of determining range, is used as follows:

a. Measure mil angle of target with binocular.

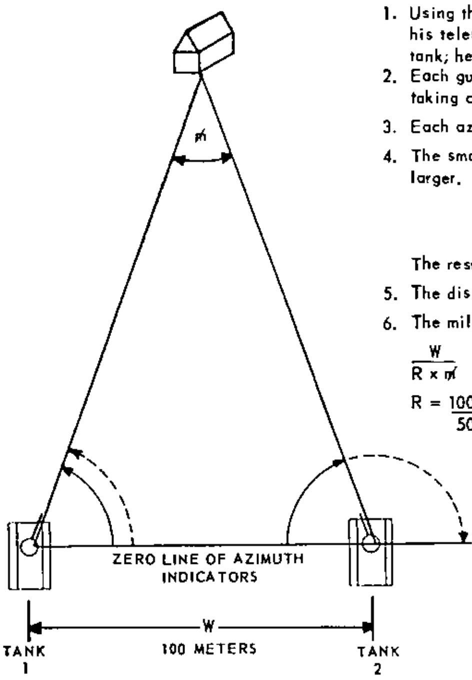
b. Find length or width of target in the chart.

c. Find range to target by reading to the right to the range under the mil angle measured with binocular.

2. This chart may be made readily available in a convenient location near the tank commander's position in the tank.

3. Range figures on above chart are rounded off to the nearest hundred.

Figure 48. A range determination chart.



1. Using the boresight cross, each gunner alines his telescope on the telescope port of the other tank; he then zeroes his azimuth indicator.
2. Each gunner traverses directly to the target, taking care to aim on the same point.
3. Each azimuth indicator reading is recorded.
4. The smaller reading is subtracted from the larger.

$$\begin{array}{r} 1628\ \not{m} \\ -\ \underline{1578} \\ 50 \end{array}$$

The result is the apex angle ($\not{m}$).

5. The distance (W) between the tanks is measured.
6. The mil relation is then used to solve for range.

$\frac{W}{R \times \not{m}}$ or, removing the unknown, $R = \frac{W}{\not{m}} =$

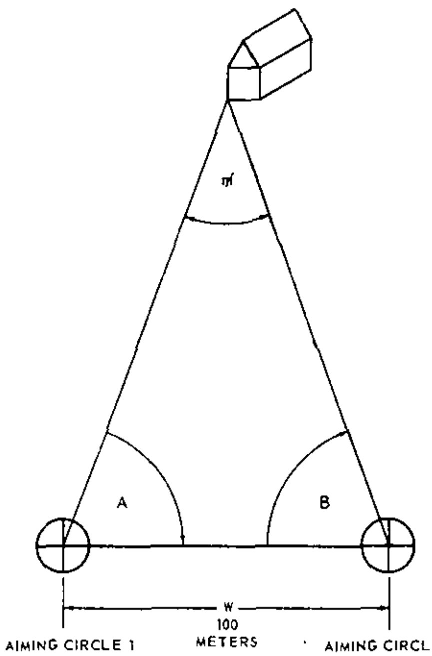
$R = \frac{100}{50} = 2$ or range $= 2 \times 1000 = 2000$ meters.

Note. The dotted lines indicate the angle measured.

AZIMUTH INDICATOR READING: 1578 $\not{m}$

AZIMUTH INDICATOR READING: 1628 $\not{m}$

Figure 49. Determining range by intersection—two-tank method.



1. Aiming circle 1 measures angle A, which is the angle from the target to aiming circle 2.
2. Aiming circle 2 measures angle B, which is the angle from aiming circle 1 to the target.
3. These two base angles are added (angle A + angle B).
4. The sum of the base angles is subtracted from 3200 mils (the total number of mils in a triangle).
5. The result is the apex angle (m̸).
6. The distance (W) between aiming circles is measured.
7. The mil relation is then used to solve for the range to the target.

Angle A = 1578 m̸
Angle B = 1572
Total 3150

Apex angle (m̸) = 3200 − 3150 = 50 m̸

Using the mil relation:

$\frac{W}{R \times \text{m̸}}$ or $R = \frac{W}{\text{m̸}}$

$R = \frac{100}{50} = 2$

Range = 2 × 1000 = 2000 meters

Figure 50. Determining range by intersection—summation of angles method.

them. He then applies this measured distance to the graphic scale on his map and obtains the range. The accuracy of this method depends on the accuracy of the individual in locating the positions of both tank and target and the accuracy of the map.

84. Intersection

When time and equipment are available, intersection is an accurate method of determining range.

a. Two-Tank Method (Primary). To use this method, establish a triangle using the target as the apex. Place a tank at each end of the known base of the triangle (fig. 49).

b. Summation of Angles (Alternate). To use this method, establish a triangle using the target as an apex. Measure the angles at each end of the base of a triangle using any angle-measuring instruments (fig. 50). If only one instrument is available, both positions are marked by stakes and the aiming circle or other instrument is moved from one position to another.

85. Registration

The most accurate method of determining range for firing a particular weapon is registration with that weapon. One method is: Determine the range to a target by use of a range finder or by estimation, index this range into the fire control system, lay on the target with the primary sight, and fire. If the target is hit in the center, the range is correct. If not, apply the primary method of sensing adjustment (pars. 106–108) without firing. Refer the aiming cross of the sight to the center of the target by changing the range indexed in the computer (with turret power off on fire control systems with a superelevator) or ballistic unit. If may not be practical to use registration as a means of determining range, as it discloses the position of the weapon and may require an excessive expenditure of ammunition.

86. Friendly Troops

Tank crewmen may obtain the range to a target from friendly troops. The information thus obtained, however, is only as accurate as the method used by the friendly troops.

PART FOUR
CONDUCT OF FIRE

CHAPTER 6
INTRODUCTION

87. Scope

Part four explains conduct of tank fire. Conduct of fire comprises methods and techniques used by the tank crew to engage and destroy enemy targets with a minimum expenditure of time and ammunition.

88. General

a. The tank is an offensive weapon, possessing armor-protected firepower and a high degree of mobility. The ability of armor to concentrate devastating fire on the enemy while aggressively advancing on his position produces the shock action essential to success in battle.

b. The primary mission of armor units is to close with and destroy the enemy. Tank units perform this mission by a penetration or envelopment of the enemy position, following with exploitation and pursuit of the defeated enemy forces. Even in a defensive situation, tanks are used offensively as the principal element of the counterattack force or mobile reserve. In either situation, the mission is accomplished by employing firepower and maneuver.

89. Firepower

The most effective firepower is obtained by using direct fire, concentrating the massed, coordinated fire of the entire tank unit. Direct fire (ch. 7) is fire delivered on targets that can be observed through the direct-fire sights. It is the most effective method of firing tank guns because of the accuracy and rapidity with which enemy targets can be engaged, and should be employed in preference to indirect fire. Indirect fire (ch. 8) is fire delivered on targets that cannot be observed through the direct-fire sights either because of poor visibility conditions or the position of the tank. This type of fire is not as effective as direct-fire because it is neither as accurate nor as rapid. The relatively flat trajectory of projectiles fired from tanks in complete defilade and the capability of only low-angle fire prevent engagement of targets close behind a mask. Although indirect fire from completely defiladed positions is not a primary function of tank units, and is employed only under exceptional conditions, tank crewmen receive training in indirect laying because it is a means of employing the firepower of the tank unit against the enemy when the tactical situation, terrain, or weather does not permit direct-fire and maneuver and when other more suitable firepower is not available.

90. Target Acquisition

a. Target acquisition includes detection, location, and identification of ground targets for purposes of target analysis, target evaluation, and the effective employment of weapons. Targets are broadly classified as point or area, according to their nature. A point target is one that consists of a particular object or structure, such as a tank, gun position, or bunker. An area target consists of a general location or area on which fire is to be delivered, such as a defensive position, an assembly area, or troops dispersed.

b. Targets are further classified as hard or soft, according to the type of ammunition necessary for destruction. Hard targets are those that cannot be penetrated by small arms fire or the fragmentation effect of high explosive ammunition. The most common types of hard targets are armor-protected vehicles, bunkers, and pillboxes. Soft targets are those that can be defeated by small arms fire and shell fragments, such as troops in the open, unarmored vehicles, and open gun positions.

c. Within the tank crew, target acquisition is the responsibility of the tank commander, but he is assisted by the other crew members. Acquisition should be rapid and accurate, so that the target can be engaged quickly with the correct type of ammunition. This is not an easy task, because enemy positions and weapons will often be concealed and camouflaged. Even when an enemy gun opens fire, the haze and noise of battle make target acquisition difficult.

d. To assist the tank commander, each crewman is assigned a sector for observation. The tank crewman who first observes a target will alert the remainder of the crew to its presence. The tank commander does this by issuing an initial fire command. Other crewmen designate a target by announcing the target description and follow with the range and direction; for example, TANK, 1,000, DIRECT FRONT. Should the tank commander decide to engage a target designated by another crewman, he will then issue a fire command. For training in target acquisition see paragraphs 228 through 230.

Note. The gunner and loader give direction in relation to the tank turret, and the driver in relation to the tank hull.

91. Firing Positions

a. The ideal firing position is one that provides cover, concealment, and level hardstanding. Hull defilade positions, where the hull is behind cover and the turret exposed, are employed for direct fire. Indirect fire is conducted from positions affording complete or turret defilade. Firing positions must be as level as possible in order to eliminate or reduce cant (par. 58). In a static situation, selection and occupation of positions are deliberate. However, ideal firing positions are not always available in mobile situations. Rapid selection and immediate occupation of a position is a crew effort, requiring close teamwork between crew members. Selection of the final position is the tank commander's responsibility, but a trained driver will constantly search for good positions so that he can move in immediately when ordered to do so. Rapid engagement of the target has priority over selection of a firing position. Situations may arise where a dangerous target will be engaged from an exposed firing position in an attempt to take the target under fire before the enemy is able to take your tank under fire.

b. When moving from turret to hull defilade, the driver is directed by the gunner. With the gun level, the gunner looks through the telescope and halts the driver when the target area is visible. Any time it becomes doubtful as to whether or not the projectile will clear the mask, the loader should check by sighting along the bottom of the gun tube and if any of the mask is visible, the tank's position must be changed accordingly.

c. Although the machineguns can be fired effectively from a moving tank (pars. 132 and 133), shooting on the move with the main gun is extremely difficult and inaccurate. The tank gun will be fired habitually from stationary positions except in emergencies or unless the tank gun is stabilized.

92. Employment of Tank Weapons

The decision of whether to employ the main gun, the coaxial machinegun, or the caliber .50 machinegun, is primarily based on considerations of target vulnerability and range (pars. 142–147). The main gun is used to engage such hard targets as armor and fortifications, and soft targets that are beyond the effective range of the machineguns. The tank machineguns are employed against soft targets at close ranges, such as troops and thin-skinned vehicles. The main gun has the greater destructive effect; however, machineguns have a greater volume of fire, give better area coverage, and can be more rapidly adjusted. The machineguns can be effectively fired from a moving tank and should be employed in the final assault of an objective because of their combined destructive, neutralization, and psychological effect against the defenders. When either weapon would be equally effective, the machinegun should be employed because of its greater volume of fire and the resulting conservation of tank gun ammunition for engagement of targets beyond the capabilities of the machinegun.

CHAPTER 7
DIRECT FIRE

Section I. INTRODUCTION

93. General

Tanks employ direct fire whenever the target can be seen through the direct-fire sights. Direct tank fire is the most rapid and accurate fire; therefore, the most effective. This chapter discusses direct fire engagement of enemy targets, initial and subsequent fire commands, adjustment of fire on stationary and moving targets, crew duties when engaging targets, and special techniques of target destruction. The information contained in this chapter is applicable to all standard tanks.

94. Firing Duties

Effective fire of tank weapons is dependent on the skill and coordinated action of the tank crew. The general firing duties performed by the individual members of the crew are listed below.

Tank Commander	Controls movement of the tank and actions of the crew; observes for and selects targets; gives initial fire commands and, when necessary, subsequent commands; lays tank guns for direction; determines range to targets; supervises the gunner in adjusting fire; controls volume of fire; and fires cupola- or external turret-mounted machinegun.
Gunner	Observes for targets; aims and fires the main gun and the coaxial machinegun by use of direct-fire sights or auxiliary fire control equipment; adjusts fire of the main gun and the coaxial machinegun.
Loader	Observes for targets; loads the main gun and the coaxial machinegun; inspects, cleans, and

	stows ammunition; reduces stoppages, and assists in the removal of misfires and reduction of other malfunctions.
Driver	Observes for targets; maneuvers and positions the tank for firing.

Section II. INITIAL FIRE COMMANDS

95. General

The initial fire command contains only the information necessary for the crew to load, aim, and fire the tank weapons. An initial fire command is issued by a tank commander to his crew and by a platoon leader to his platoon or specific tanks for each target engagement. Standard terminology and logical sequence are used to achieve effectiveness and speed. The type of equipment used may allow omission of certain elements of the command; however, the sequence remains the same. For stationary targets, the initial fire command contains 4, 5, or 6 elements; for moving targets, 5, 6, or 7 elements. Given below is an example of an initial fire command, showing sequence of elements and actions performed by the crew as each element is announced.

Element	*Example*	*Crew firing duties*
Alert	GUNNER	Entire crew is alerted. Gunner turns on turret power switch. Tank commander commences laying gun for direction, using his power control handle.
Ammunition (and fuze, if necessary), weapon, or searchlight.	SHOT	Loader (or gunner on some type tanks) places safety in FIRE position, if necessary. He selects and loads the announced ammunition, setting the fuze if necessary, remains clear of recoil, and announces UP. The gunner turns on the appropriate gun switch and indexes the announced ammunition in the computer. If using a ballistic unit or telescope, the gunner notes the an-

Element	*Example*	*Crew firing duties*
		nounced ammunition and awaits next element of the initial fire command.
Range (omitted when range finder is used).	ONE TWO HUNDRED	If range is announced, gunner indexes the range in the computer or ballistic unit or uses the appropriate range line on the telescopic sight. On tanks equipped with a range finder, ranging does not take place at this time.
Direction (omitted when tank commander lays for direction).	TRAVERSE RIGHT—STEADY—ON	If direction is announced, gunner follows instructions of tank commander, who uses his direct-fire sight, when necessary, to insure that gunner lays on selected target.
Description	TANK	Upon hearing description and observing the target in the direct-fire sights, gunner announces IDENTIFIED. Tank commander then releases his control, and gunner positions the reticle so tank commander can range on target, if necessary. If this is not necessary, gunner immediately places the appropriate part of the reticle on center of vulnerability of target.
Lead (used only when engaging targets with apparent speed).	ONE LEAD	Gunner takes the announced lead from center of vulnerability of target and maintains it by tracking before, during, and after firing.
Execution	FIRE	After the command FIRE, gunner makes the final precise lay, announces ON THE WAY, and fires. If

Element	*Example*	*Crew firing duties*
		tank commander uses the range finder, he does not command FIRE until he has completed ranging. If for some reason tank commander decides not to fire immediately, he commands AT MY COMMAND, following with FIRE at the appropriate time.

96. Alert Element

a. The alert is the first element of the initial fire command. It alerts the crew to the presence of a target and, in the case of a platoon command, designates the tank or tanks with a mission.

b. Standard terminology is used for the alert. Examples are—

(1) GUNNER	Tank commander alerts entire crew to a fire mission.
(2) PLATOON, FIRE MISSION.	Platoon leader alerts entire platoon to a fire mission.
(3) NUMBER THREE, FIRE MISSION (WHITE (RED) LIGHT MISSION).	Platoon leader alerts a specific tank crew to a mission.
(4) NUMBERS TWO AND THREE, FIRE MISSION; NUMBERS FOUR AND FIVE, RED (WHITE) LIGHT MISSION.	Platoon leader alerts tank crews and assigns missions.

Note. The radio call word for the entire platoon or for a specific tank is substituted for the unit designation or tank number. If the only mission assigned by a platoon leader is a light mission, the second element of the command is omitted. If the tank-mounted searchlights in a unit do not have a dual capability, use only the words LIGHT MISSION to indicate illumination.

c. The gunner turns on the turret power switch, if it is not already on, so the tank commander can begin laying the gun for direction.

97. Ammunition, Weapon, or Searchlight Element

a. The following terms are used in announcing the ammunition, weapon, or searchlight element.

Ammunition	*Term*	*Type targets normally engaged*
High explosive (standard fuze set on superquick).	HE (pronounced AITCH–EE).	Troops, crew-served weapons, and unarmored and lightly armored vehicles.
High explosive (standard fuze set on delay).	HE DELAY	Dug-in troops or wooden structures.
High explosive (with concrete-piercing fuze).	HE CONCRETE.	Bunkers and pillboxes.
Armor-piercing (AP).	SHOT	Light and medium tanks.
Hypervelocity armor-piercing (HVAP).	HYPERSHOT.	Heavy tanks.
[1]Hypervelocity armor-piercing, discarding sabot (HVAP–DS or APDS).	SABOT (pronounced SA–BO).	Heavy tanks.
High explosive antitank.	HEAT (pronounced HEAT).	Heavy tanks, bunkers, pillboxes.
High explosive plastic.	HEP (pronounced HEP).	Light and medium tanks, troops, crew-served weapons, and unarmored and lightly armored vehicles.
[1]Canister.	CANISTER	Troops.
White phosphorus.	SMOKE	For screening, incendiary, or casualty-producing effect.
Weapon	*Term*	*Type targets normally engaged*
Coaxial machinegun.	COAX (pronounced KO-AXE).	Same as HE up to maximum effective range.
Caliber .50 machinegun.	CALIBER FIFTY.	Same as HE up to maximum effective range.
[1]Flamethrower.	FLAME THROWER.	Bunkers, pillboxes, and other field fortifications.
[2] *Searchlight*	*Term*	*Use*
Visible light.	WHITE LIGHT	Illumination of targets.
Infrared light.	RED LIGHT	Illumination of targets when infrared sights are used.

[1] Cannot be fired over friendly troops.

[2] Term used by tank commanders as second element of the command when appropriate. Platoon leaders designate, when necessary, in the alert element, followed by the word MISSION (par. 96).

b. There are two types of point detonating fuzes for high explosive shells: a fuze with a setting for superquick or delayed detonation and a concrete-piercing fuze (fig. 5). The fuzes are interchangeable and either may be affixed to a round by the crew. HE rounds are issued to a unit and stowed in the tank with the fuze set on superquick (SQ). To obtain delay action, the tank commander announces HE DELAY, and the loader turns to delay setting. If no fuze is mentioned, the loader loads HE with the superquick setting. Concrete fuzes are issued separately and are mounted on the round by the crew. The concrete fuze is announced as HE CONCRETE. Smoke has a point detonating fuze that can be set on superquick or delay.

c. Upon hearing the ammunition element, the loader immediately loads the announced type, checks to insure all crew members are clear of the path of recoil, and announces UP. He continues to load the announced type of ammunition until a change in ammunition or CEASE FIRE is given.

d. The gunner turns on the appropriate gun switch and indexes the announced ammunition in the computer. If using a ballistic unit or telescope, the gunner notes the announced ammunition and awaits the announcement of the next element of the initial fire command.

e. The main gun or coaxial machinegun safety, is placed in the FIRE position, if necessary, by either the loader or the gunner, depending on its location.

98. Range Element

a. When the tank commander ranges on the target or when he indexes the range into the fire control system, the range element is omitted from the initial fire command. When range must be announced, it normally will have been obtained by estimation and is then announced to the nearest 100 meters (yards). However, if the tank commander accurately determines the range, he will announce it to the nearest 50 meters (yards). Because crewmen know the standard unit of measure for range on their tank, the words "range," "meters," or "yards" are not included in the range element.

b. For clarity and standardization, all numbers (range, deflection, and elevation) used in fire commands are announced as follows:

25	TWO FIVE
100	ONE HUNDRED
250	TWO FIVE ZERO

1,800	ONE EIGHT HUNDRED
3,000	THREE THOUSAND
4,050	FOUR ZERO FIVE ZERO

c. If range is announced, the gunner indexes range in the computer or ballistic unit or uses the appropriate range line in the telescopic sight.

d. The platoon leader announces range in his fire command to assist his tank commanders in locating the target. The tank commanders index or announce this range unless their distance from the platoon leader would cause this range to be in error, in which case they determine their own ranges.

99. Direction Element

When the tank commander lays the gun for direction, this element will be omitted in the initial fire command. He lays the gun while issuing the command, making an approximate lay by sighting along the gun tube (or vane sight if tank is so equipped) and a more precise lay, if necessary, by using his direct-fire sight. If the tank commander's power control is inoperative, if he is otherwise engaged, or if a platoon leader is issuing an initial fire command to his unit or to a tank other than his own, it will be necessary to include the direction element. Examples of laying a single tank or tank unit for direction are listed in *a* through *d* below.

a. *Traverse Right (Left)—Steady—On*. The tank commander commands TRAVERSE RIGHT (LEFT), and the gunner traverses rapidly in the announced direction. As the gun approaches the direction to the target, the command STEADY is given, and the gunner slows his traverse. When the gun is laid on or near the target, the tank commander commands ON, and the gunner stops traversing. The tank commander uses his direct-fire sight to insure that the gun is laid on the selected target.

b. *Reference Point and Deflection*. To assist the gunner in identifying the target, the tank commander may use a reference point and a shift in mils. The reference point must be one that the gunner can easily recognize. The tank commander measures, with his binocular, the deflection from the reference point, and announces the shift. For example, he commands REFERENCE POINT CROSSROADS, RIGHT THREE ZERO. The gunner lays the aiming cross of his direct-fire sight on the reference point, zeroes his azimuth indicator and gunner's aid, traverses right 30 mils, and looks for his target. Small shifts may be made by using lead line in the sight reticle.

c. General Direction. When the target is unmistakable, the platoon leader may command DIRECT (LEFT OR RIGHT) FRONT or RIGHT (LEFT) FLANK. This method is normally used to direct a platoon, but may be used also to direct the gunner. DIRECT FRONT, when given by a tank commander to his crew, is the direction in which the main gun is pointing, not necessarily the front of the tank. When given by the platoon leader to his unit, it indicates the direction in relation to the platoon's position.

d. Firing Gun. To lay the platoon for direction rapidly and accurately, or to identify an obscure target, the tank commander or platoon leader may fire one of the machineguns or the main gun at the target. The direction element is then announced as WATCH MY TRACER (BURST). When the platoon leader's tank is not visible to all tanks or when other fire is being placed in the target area, it may be necessary for the platoon leader to combine methods, such as RIGHT FRONT, WATCH MY BURST.

100. Description Element

a. The description element is always announced so that the gunner can rapidly identify and lay on the target. To avoid misunderstanding, the description must be clear and concise. Most of the targets encountered can be designated by using the following standard terminology:

Any tank or tank-like vehicle*	TANK.
Any unarmored vehicle	TRUCK.
Any armored personnel carrier	PERSONNEL CARRIER.
Any half-track vehicle	HALF TRACK.
Personnel	TROOPS.
Any type of machinegun	MACHINEGUN.
Any antitank gun or towed artillery piece.	ANTITANK.
Any other target	Briefest term consistent with clarity.

b. If several targets are in view, the tank commander can specify the particular target by announcing FIRST TANK or LAST TRUCK or by some other brief description. When a target is concealed, it is described as it appears to the gunner; for example, GREEN BUSH—ANTITANK or LEFT WINDOW—TROOPS. When a target to be engaged is plotted on a range card, the target number is used as the description element by the platoon leader in his command to other tank commanders (par. 150).

*Armor-protected, full-track vehicles with a gun capable of destroying tanks, e.g., self-propelled artillery piece.

c. When the gunner has positively identified the target, he will immediately announce IDENTIFIED, not waiting for the tank commander to finish the initial fire command or make a precise lay on the target. This is the signal for the tank commander to release his power control handle. The gunner then takes control of the gun, positions the reticle for ranging, if necessary, or makes the final precise lay on the target on tanks not equipped with a range finder.

101. Lead Element

The lead element is included in the initial fire command when a target with apparent speed is engaged. A moving target is initially engaged with one lead (5 mils) regardless of range or speed of the target (pars. 120–123).

102. Execution Element

a. The command to fire is announced as FIRE. This command tells the gunner to fire as soon as he is ready. If the tank commander is determining range by use of a range finder, he will not command FIRE until he has completed ranging and positioned himself to sense the round.

Note. Except when the range finder is being used to range on a target, the right optical system of the coincidence-type range finder is kept occluded (shut off). This is necessary so that the view through the range finder will show a single instead of a double image.

When the tank commander decides to open fire at a specific time, he will command AT MY COMMAND, following, when ready, with FIRE. Before firing, the gunner announces ON THE WAY. During periods of training, for safety reasons, *the gunner will pause approximately 1 second between announcing ON THE WAY and firing.* In combat, where rapid engagement of enemy targets is vital, there will be no pause. The gunner continues to fire, without further command, until the tank commander commands CEASE FIRE or otherwise assumes control of the firing.

b. If the tank commander decides to fire the weapon himself, he will announce FROM MY POSITION as the execution element (par. 139).

c. The platoon leader directs AT MY COMMAND when he decides to have two or more tanks fire simultaneously. Tank commanders signal when ready and the platoon leader commands FIRE at the desired moment. If the platoon leader wants a tank crew to fire as soon as they are ready, he commands FIRE as the execution element.

d. For execution elements when employing tank-mounted searchlights, see paragraph 157*b*(6) (*c*).

Note. If the main gun fails to fire the gunner announces MISFIRE, and if the coaxial machinegun fails to fire he announces STOPPAGE. The failure of a weapon to fire may be due to a faulty weapon or round of ammunition. In any event, certain time intervals and procedures must be followed to minimize the dangers of a hang fire or cook off. These time intervals and procedures are outlined in AR 385-63.

103. Repeating an Initial Fire Command

a. When a crew member fails to hear or understand any element of an initial fire command, he announces such elements as a question. For example, AMMO? DESCRIPTION? or AMMO-RANGE?

b. When a crew member requests repetition of any part of the initial fire command, the tank commander repeats only the elements requested. For example, if the gunner or loader asks AMMO?, the tank commander repeats SHOT.

c. If the gunner does not announce IDENTIFIED, he has failed to positively identify the target. If, after laying the aiming cross on the target and repeating the description, the gunner still fails to identify the target, the tank commander will take over firing of the weapon (par. 139).

104. Correcting an Initial Fire Command

a. To correct an error in an initial fire command, the tank commander announces CORRECTION and corrects the element in error. He then completes the command by announcing all elements after the corrected element.

Examples:

GUNNER HE TANK CORRECTION ANTITANK FIRE.	GUNNER SHOT ONE SIX HUNDRED TANK FIRE CORRECTION TWO SIX HUNDRED TANK FIRE.

b. The tank commander normally will not correct an error in the ammunition element after the gun has been loaded unless the supply of ammunition is critical; instead, he will allow the gunner to fire the chambered round, then will give a change in the ammunition as a subsequent fire command. In the following examples the tank commander announced SHOT in the initial fire command and the loader loaded shot before the tank commander realized his mistake.

Tank commander desires to unload chambered round:	Tank commander desires to have chambered shot round fired:
CORRECTION HE ANTITANK FIRE.	FIRE HE

c. It is not necessary to correct an error in sequence unless it prevents the crew from properly performing its duties; in this case, the announcement of CORRECTION will be made and a new fire command issued.

d. No attempt will be made to correct an element that has been unnecessarily included; e.g., direction element included when the tank commander has laid the gun for direction.

e. The omission of an element is corrected by the announcement of CORRECTION and the omitted element, and the command is completed.

Example.

GUNNER
TANK
CORRECTION
SHOT
TANK
FIRE.

105. Subsequent Fire Commands

Any fire command issued after the initial fire command has been executed is a subsequent fire command. The tank commander issues subsequent commands to change elements in an initial or a subsequent fire command, to cease fire, and to take over the adjustment of fire (pars. 113–116).

Section III. SENSINGS

106. General

A sensing is a mental notation based on observation of the round as it appears in relation to the target. Every round fired is sensed, when possible, for deflection and range, by both the tank commander and the gunner. A tracer round is sensed where the tracer strikes short of, passes, or hits the target; nontracer rounds are sensed at the point of burst. The strike or burst must be sensed immediately to avoid errors caused by drifting smoke or dust. To obtain correct sensings when firing tracer rounds,

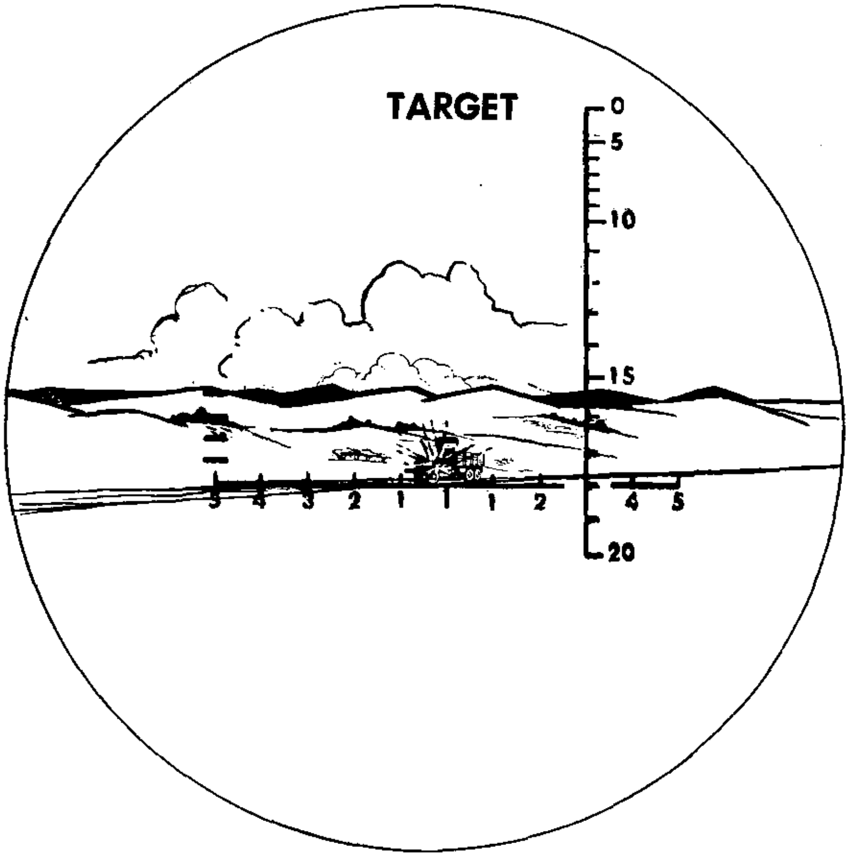


*Figure 51. Sensing of **target** (as seen by the tank commander).*

crewmen must concentrate on the target and not attempt to follow the flight of the projectile. The gunner uses his direct-fire sight as an aid in sensing, while the tank commander uses his binocular. (See par. 157*b* (2) for sights used during periods of poor visibility.) The tank commander may use his direct-fire sight for sensing when, for some reason, his hatch must be closed.

107. Deflection Sensings

Deflection sensings are mental notations of whether the round is on line with or to the side of the aiming point. There are three deflection sensings: right, left, and line. These sensings are measured as so many mils left or right of the target and are *not* announced. For example, the tank commander or gunner might sense a round as *two left* or *line*. Normally, there will be little

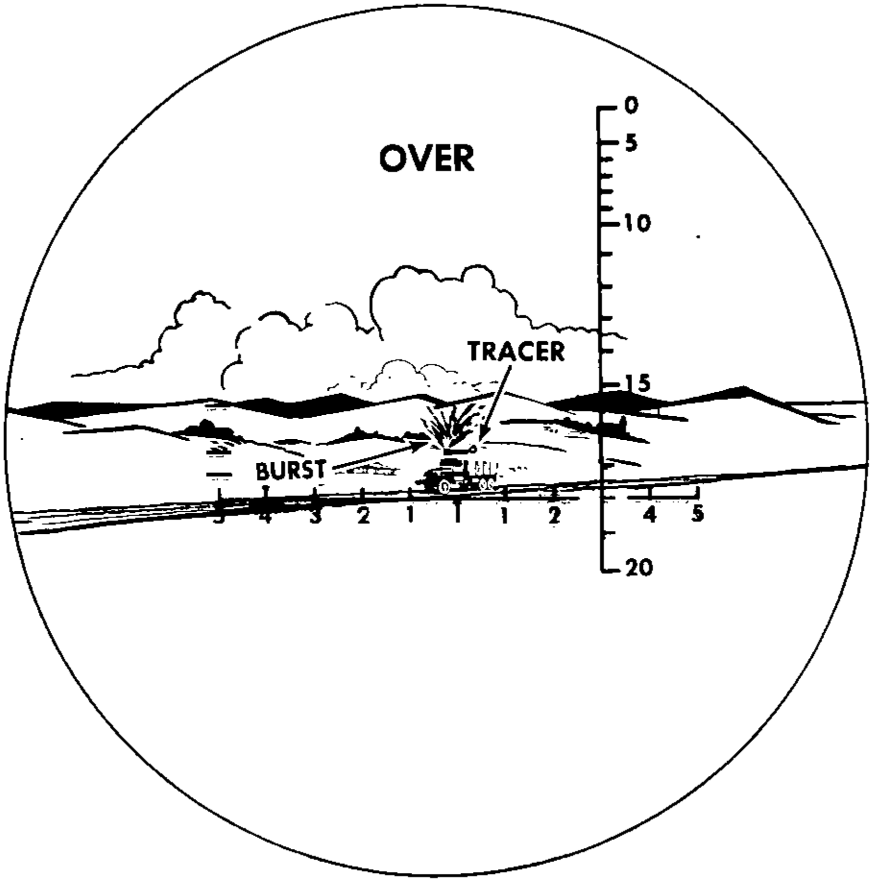


*Figure 52. Sensing of **over** (as seen by the tank commander).*

or no error in deflection if sight adjustment has been performed properly.

Note. Only the tank commander measures the deflection error. The gunner merely notes the point on his sight reticle where the round appears in relation to the target.

108. Range Sensings

There are five range sensings: *target, over, short, doubtful,* and *lost.* These sensings are mental; however, *under certain circumstances they are announced.* If the gunner cannot observe his tracer or burst during sensing adjustment, he will announce his sensing as LOST (par. 113*a*). *This is the only sensing announced by the gunner during sensing adjustment. During non-sensing adjustment (par. 117) he does not announce LOST, but does indicate when the round is observed short of the target by announc-*

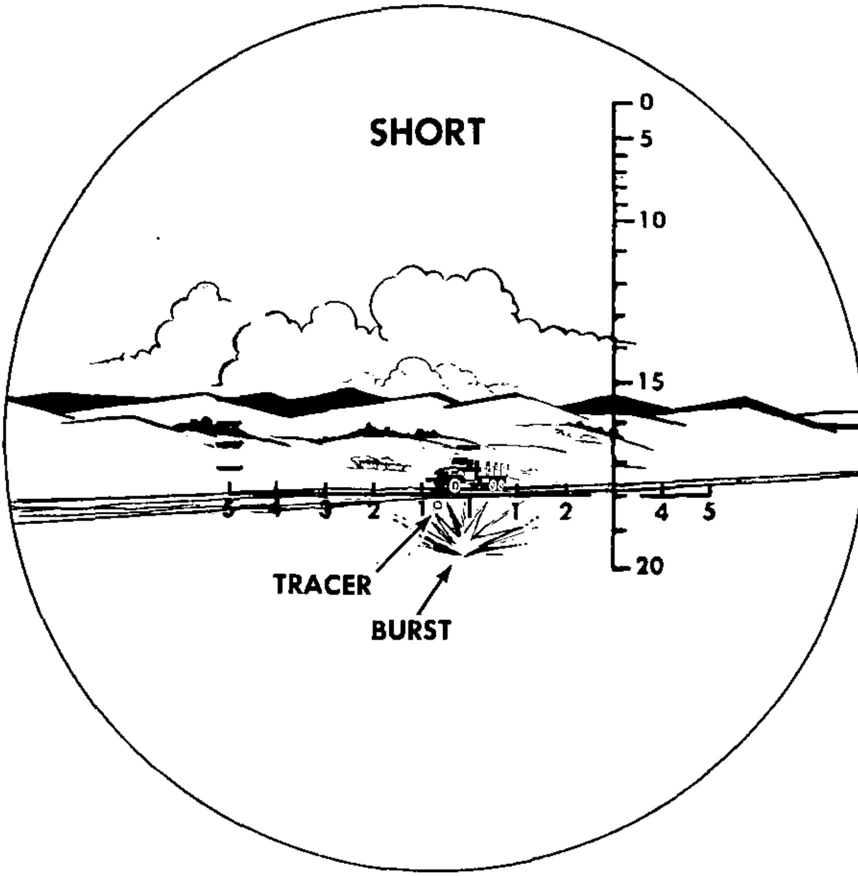


*Figure 53. Sensing of **short** (as seen by the tank commander).*

ing SHORT. The tank commander will announce his range sensing when the gunner announces LOST or anytime he takes over adjustment of fire.

a. Target. In tank gunnery, a round is sensed as *target* (fig. 51) when the round or shell fragments strike the target. A hit may cause the target to change shape, move, disappear, or burn, or pieces to fly off it. When any high explosive or armor-defeating round strikes a metal object, there is usually a bright flash. A hit on any part of the target is sensed as *target,* even though adjustment to a more vulnerable part may be required to obtain target destruction.

b. Over. A round is sensed as *over* (fig. 52) when the burst appears beyond or the tracer passes above the target. A tracer

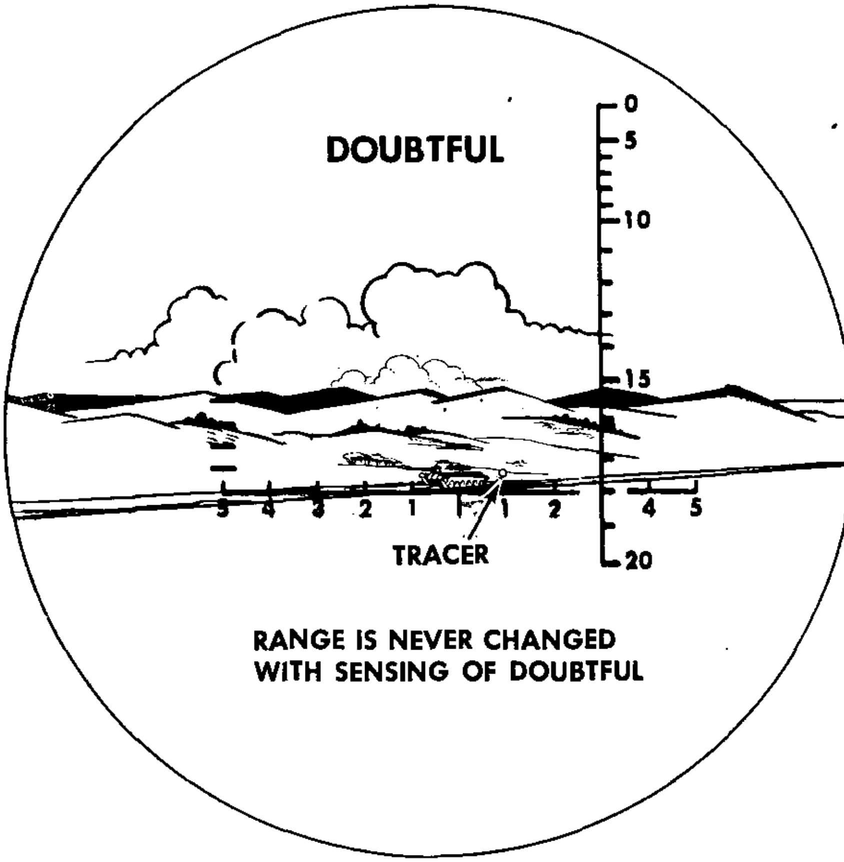


Figure 54. Sensing of **doubtful** *(as seen by the tank commander).*

round is sensed at the point where it passes over the target; a nontracer round is sensed at the point of burst. Overs are also sensed for deflection; for example, *over, three right.*

c. Short. A round is sensed as *short* (fig. 53) when either the burst or the strike is observed between the gun and the target. Both tracer and nontracer rounds are sensed at the point of burst or strike. The strike must be observed carefully and sensed immediately, as the target, just after the strike, is sometimes temporarily obscured by smoke and dust. Short rounds are sensed also for deflection; for example *short, line.*

d. Doubtful. A round is sensed as *doubtful* (fig. 54) when it appears to be correct for range but the tracer passes or the burst strikes left or right of the target. As a deflection correction is usually sufficient to obtain a target hit, no range change is made

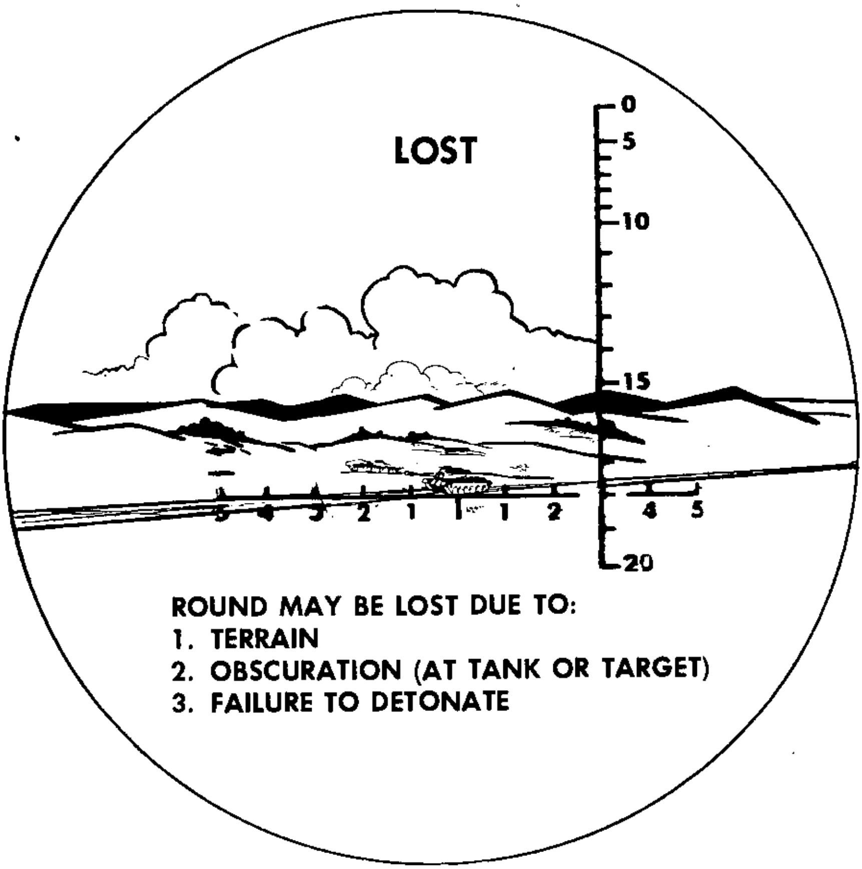


Figure 55. Sensing of lost (as seen by the tank commander).

on a *doubtful* sensing. An example of this sensing is *doubtful, two right.*

e. Lost. A round is sensed as *lost* (fig. 55) when the gunner or tank commander fails to observe the point of strike, burst, or tracer. It may not be visible due to obscuration, terrain, failure of the tracer element to ignite, or failure of the round to detonate. Based on his knowledge of the terrain, the tank commander may make a range change if he feels that the round has been lost due to terrain. This is the only sensing that is announced by the gunner. It must be announced when he uses the sensing method of adjustment so that the tank commander will know that the gunner cannot observe the round.

Note. There is no mechanical method for measuring range error. For the first round adjusted for range, the standard range change is used; for subsequent adjusted rounds, range is estimated by the tank commander (par. 113). Again the gunner merely notes the point on his sight reticle where the round appears in relation to the target.

Section IV. ADJUSTMENT OF FIRE ON STATIONARY TARGETS

109. General

a. The ultimate goal in tank gunnery is rapid target destruction with a single round. With the excellent fire control equipment and the relatively flat trajectory of tank gun projectiles, it is within the capabilities of a well-trained crew to achieve this goal consistently. This standard, however, must be approached realistically. Such factors as crew skill and target nature will obviously affect achievement of this goal. If the target is not hit or is not hit in a vulnerable spot, it is necessary to adjust fire on the target rapidly to destroy it with the minimum number of rounds.

b. There are two conditions under which fire must be adjusted. The first condition is when the tracer or burst can be observed in relation to the target. The second condition is when the tracer or burst cannot be observed or cannot be observed until it has passed several hundred meters (yards) beyond the target. The first condition usually exists when rounds with a muzzle velocity of 3,500 feet per second or less are fired at any range beyond 500 meters (yards) and at all velocities at ranges of 2,000 meters (yards) or more.

Note. There is no prescribed method of adjusting fire at ranges of 500 meters (yards) or less because of the extremely high probability of obtaining a first-round hit.

The second condition usually exists when rounds with a muzzle velocity in excess of 3,500 feet per second are fired at targets located at ranges of less than 2,000 meters (yards). Adjustment of fire under the first condition is called *sensing adjustment* (pars. 111–114) and under the second condition as *non-sensing adjustment* (par. 117). These figures on range and muzzle velocity are approximate and will vary depending on the ability and skill of the crewmen. When possible, sensing adjustment will be made in preference to non-sensing adjustment regardless of the range to the target and the muzzle velocity of the round fired, as it gives a higher probability of a hit in less time. In any case, the fact exists that certain rounds fired will be impossible to sense, and when they miss the target, subsequent rounds must be made to strike it by some method that does not require sensing.

c. Some rounds cannot be sensed because of momentary obscuration and the velocity of the round carrying it beyond the target before the sights have settled from the recoil of firing. Crewmen must be cautioned that a sensing adjustment can be made only when they actually observe the round in relation to the target; this is sensing. At times, the crewmen may be able to see the tracer through the haze of the obscuration but will not be able to see the target, or they may be able to see the tracer after it has passed the target. In such cases they have only *observed* the round and not *sensed* it. Also, a residual cloud of dust produced by a projectile striking the ground may indicate the general location of the strike. On the other hand, some crewmen, for psychological reasons, may have a tendency to rely almost solely on non-sensing adjustment, even when firing rounds with relatively low muzzle velocities and with little if any obscuration. Commanders must exercise close supervision of firing to correct the above errors. The figures on range and muzzle velocity previously cited can be used as a guide in determining these errors; e.g., if a gunner indicates that he can adjust fire with ammunition of 4,000 feet per second velocity at all ranges greater than 500 meters (yards), he must be able to prove it with consistent target hits; if he cannot, he must be retrained in sensing rounds and adjusting fire. Another situation that requires understanding and clarification is a round sensed as LOST in sensing adjustment. If experience has shown that the tank commander and gunner have been able to sense this type of round previously, the sensing method of adjustment will continue to be used.

Note. Even though some types of ammunition cannot be sensed from the firing tank because of the reasons enumerated above, they can usually be sensed from a position just a few meters to either side of the firing tank. When in a static situation and firing rounds that cannot be sensed, the dismounted observer or a two-tank method of adjustment can be used as desired (par. 141).

d. The type of adjustment to be used depends on the tank commander's and gunner's ability to sense and adjust fire with the type of ammunition selected. Each type of ammunition in the basic load must be placed in one of the two adjusting categories before targets are engaged so that the type of adjustment to be employed will immediately be known when the ammunition element of the initial fire command is announced. Otherwise a time delay would result while deciding on the method of adjustment. Normally, rounds of hypervelocity (greater than 3,500 feet per second) are not fired in training; therefore, it will be necessary for each crew to fire from 8 to 10 rounds of each type of this ammunition, when possible, before going into combat.

e. To be effective, both types of adjustment require accurate boresighting and zeroing, but these procedures have a special importance for the non-sensing method of adjustment because in this adjustment errors in firing cannot be sensed and therefore can be corrected only if they are within the limits prescribed by the non-sensing method of adjustment.

f. It must be realized also that hypervelocity rounds, though impossible to sense in most instances, are also more accurate because of the flatter trajectory of the projectile. Furthermore, the drill used in the non-sensing method is not an attempt to bracket the target, but rather to hit and destroy it as quickly as possible.

110. Center of Vulnerability

Regardless of the method of adjustment used, the adjusting or aiming point is the same. Fire is adjusted on the center of vulnerability of the target. This is the center of the most vulnerable part of the target. On many targets, this will be the exact center, but this is not always true. The center of vulnerability varies with the type of target and the angle at which it is engaged. For example, the heaviest armor of a tank is normally on the front slope plate and the turret. The most vulnerable parts of a tank are the sides and rear. When possible, the gunner should aim at these parts rather than the turret or frontal armor. If only the front of an enemy tank is in view, then the center of vulnerability is the turret ring. The purpose of aiming at or near the center of vulnerability is to increase the probability of rapid target destruction. The relatively flat trajectory of tank gun projectiles often will produce a hit somewhere on the vertical surface of the target even if the determined range is not precise. To increase the hit probability at long ranges, the aiming point is the center of the target.

111. Sensing Adjustment

When the rounds can be sensed, there are two methods of adjusting direct fire. The primary method is applied by the gunner and is known as the burst-on-target method. The secondary method involves the tank commander as well as the gunner and is known as the alternate method. With both methods, the gunner lays and fires the gun.

112. Primary Method of Sensing Adjustment

a. The primary method of sensing adjustment, burst-on-target, is the method in which the gunner observes through his direct-fire sight, re-lays immediately after firing, if necessary, and notes the point on the sight reticle where the burst or tracer appears in relation to the target. Without command from the tank commander, the gunner (by use of the gun controls) then moves that point of the sight reticle by the most direct route onto the center of vulnerability of the target, announces ON THE WAY, and fires again. He continues to fire, adjusting on the center of vulnerability, until the tank commander commands CEASE FIRE or otherwise assumes control of the firing. While the gunner makes the adjustment, the tank commander, acting as a silent observer, senses each round. The tank commander, by announcing his range sensing and issuing subsequent fire commands, takes over if he is not satisfied with the adjustment, when the gunner is firing at the wrong target, or when the gunner announces LOST.

b. Accuracy of the burst-on-target method depends on the ability of the gunner to take correct sight pictures and make precise sensings. This method is applied in the same manner on ballistic and nonballistic reticles. Properly applied, burst-on-target provides an accurate and rapid means of obtaining second-round hits or of adjusting target hits to the most vulnerable part of the target.

c. The situations in (1), (2), and (3) below, are examples of the primary method of sensing adjustment, showing gunner's application with both types of sight reticle.

(1) *Situation 1, nonballistic reticle; target, stationary tank.*

(*a*) After firing, the gunner immediately checked the lay of the gun. This round was over and to the left (fig. 56).

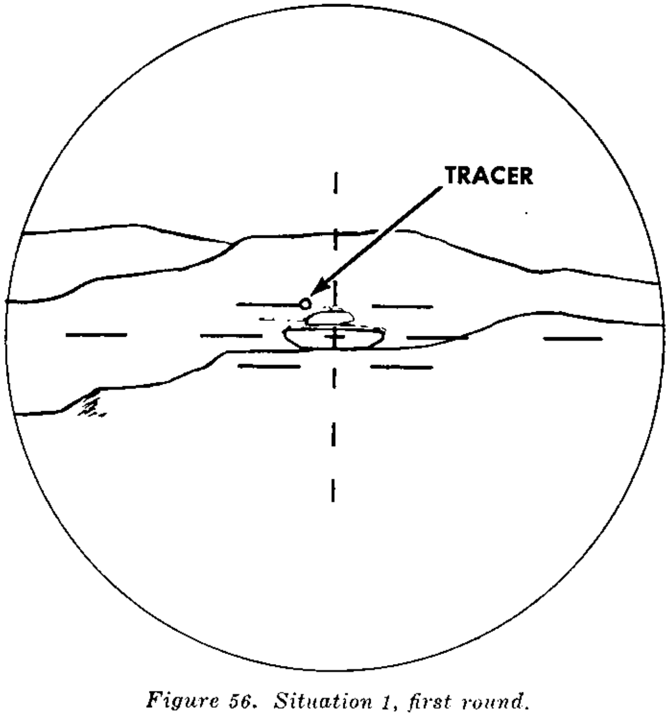


Figure 56. Situation 1, first round.

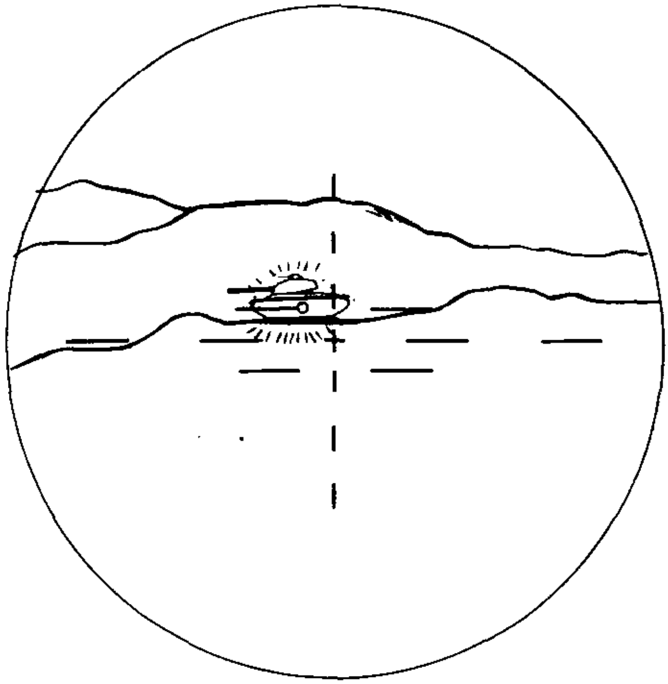


Figure 57. Situation 1, second-round hit.

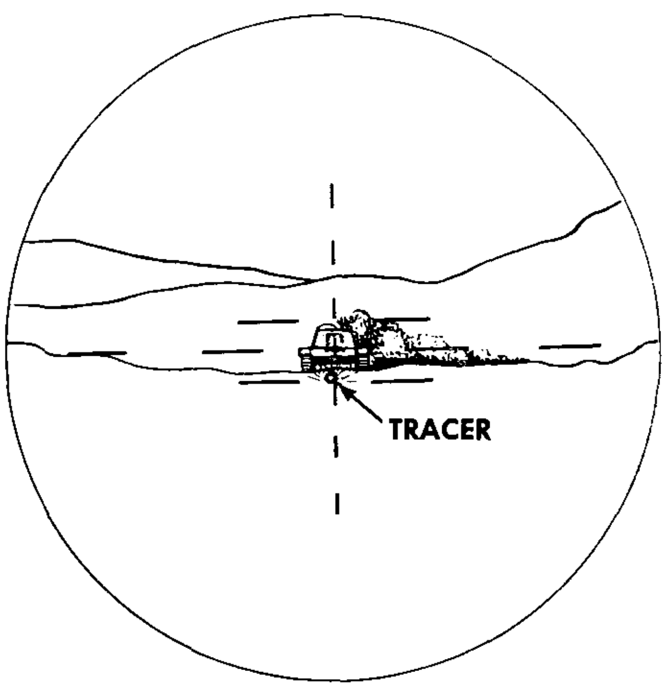


Figure 58. Situation 2, first round.

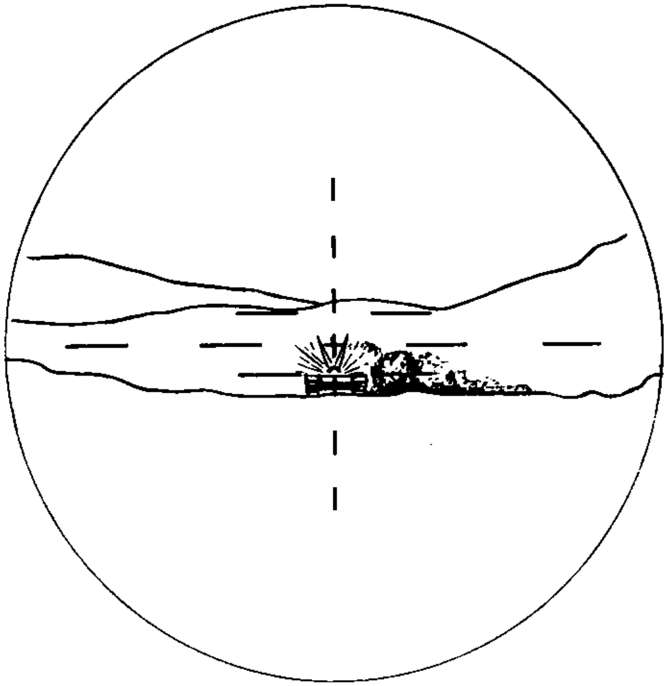


Figure 59. Situation 2, second-round hit.

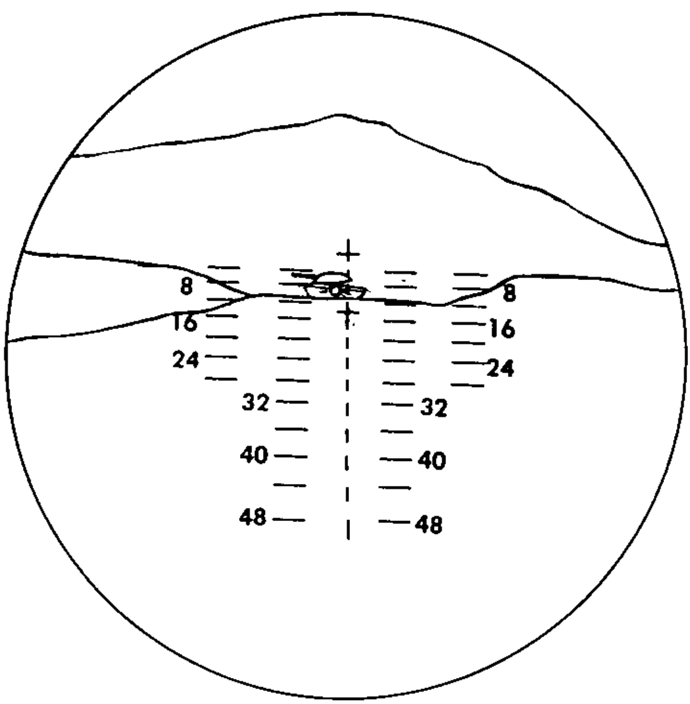


Figure 60. Situation 3, first-round hit.

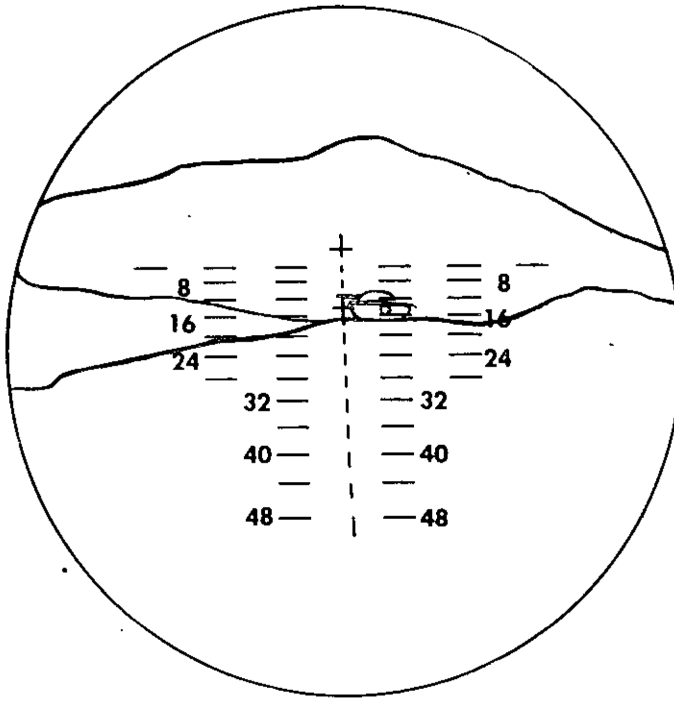


Figure 61. Situation 3, second-round hit.

(*b*) The gunner mentally noted the point on the sight reticle where the tracer passed the target and, with the gun controls, moved that point to the center of vulnerability of the target by moving the gun down and to the right. Without command, he fired again and obtained a target hit (fig. 57).

(2) *Situation 2, nonballistic reticle; target, stationary tank.*

(*a*) The gunner immediately checked the lay of the gun after firing and noted that the first round struck short of the center of vulnerability (fig. 58).

(*b*) The gunner mentally noted the point on the sight reticle where the burst appeared and, with the gun controls, moved that point to the center of vulnerability of the target. Without command, he fired the next round and obtained a target hit (fig. 59).

(3) *Situation 3, ballistic reticle; target, stationary tank (1,000 meters).*

(*a*) The gunner immediately checked the lay of the gun after firing and noted that the first round hit the target to the left of the aiming point (fig. 60).

(*b*) The gunner mentally noted the point on the sight reticle where the strike appeared, and with the gun controls, moved that point to the center of vulnerability. As the tank commander remained silent, the gunner fired again and hit the center of the tank hull (fig. 61).

d. Although burst-on-target is the most accurate and rapid method of sensing adjustment, there are certain conditions under which it cannot be effectively applied. When there is partial obscuration, or during firing over flat terrain at extreme ranges, burst-on-target is difficult to apply accurately. Also, if the gunner cannot sense the round in relation to the target, he cannot apply burst-on-target. In such cases, the alternate method of sensing adjustment is used.

113. Alternate Method of Sensing Adjustment

a. General. The alternate method of sensing adjustment is the tank commander's means of adjusting fire when the primary method cannot be used or applied effectively. An announced sensing of LOST by the gunner indicates to the tank commander that he *must* announce corrections to the gunner, because burst-on-target cannot be applied. The tank commander employs the alternate method also when it is obvious that the gunner is not adjusting properly or has made some other error, such as firing on the wrong target. The tank commander employs this method by announcing his range sensing and issuing a subsequent fire command. The announced sensing is not part of the subsequent fire command, but will precede the command as a signal to the gunner that the tank commander is going to issue a subsequent fire command.

b. Subsequent Fire Command. The tank commander issues subsequent fire commands to change an element in an initial or subsequent fire command, to cease fire, or to employ the alternate method of sensing adjustment. When used in the alternate method, the subsequent fire command may consist of one, two, or three elements. If all elements are required, they are issued in the following sequence: deflection, range, and execution. Deflection and range corrections are omitted if not required; however, the execution element is always given.

Examples.

Announced sensing:				
OVER	SHORT	DOUBTFUL	LOST	TARGET
Command:				
RIGHT TWO DROP TWO HUNDRED FIRE	ADD FOUR HUNDRED FIRE	LEFT THREE FIRE	DROP FOUR HUNDRED FIRE	CEASE FIRE

c. Deflection Corrections. The deflection element announced in the subsequent fire command is based on the tank commander's deflection sensing. The tank commander measures with his binocular the number of mils that the round passed or struck to the left or right of the center of vulnerability of the target. He then commands the gunner to shift the measured number of mils in the opposite direction. For example, if the deflection sensing is *two left*, the announced deflection correction would be RIGHT TWO. If the round is sensed as *line*, the deflection element is omitted in the command. Because lateral dispersion is negligible with tank guns, there should be little or no error in deflection. A deflection error of more than three mils indicates improper sight picture, improper boresighting and zeroing, cant error, or failure to correctly identify the target. See paragraph 120 for lead corrections.

d. Range Corrections. The range element of the subsequent fire command is based on the tank commander's range sensing. If the round is short, the tank commander adds range; if the round is over, he drops range. Range is changed for the first round adjusted for range by use of the standard range change. The purpose of the standard range change is to obtain a target hit, to move the strike of the round closer to the target so the gunner can observe the round and apply burst-on-target, or to provide a mental yardstick on the ground if the tank commander must continue to adjust. The standard range change applies only to the first round adjusted for range for sensing adjustments and only on sensings of *over* and *short.*

Note. If the primary method of adjustment is employed first, then a range change is presumed to have been made.

Once an adjustment has been made (either by burst-on-target or the alternate method) the tank commander is no longer held to the standard range change, but may make any range change he feels is necessary to hit the center of vulnerability. Range changes are made in multiples of 50 meters (yards). The amount of the standard range change depends on the method initially used to determine the range.

(1) When a range finder or other accurate means (intersection or registration) has been used to determine the initial range to the target, the standard range change is ADD or DROP 200 meters (yards) regardless of the tank-to-target range. If the gunner fails to observe the first round, he announces LOST. The tank commander then announces his range sensing and issues a subsequent fire command, making any necessary deflec-

tion change and adding or dropping 200 meters (yards) with a sensing of *over* or *short.* If the next round does not destroy the target, the gunner applies burst-on-target if possible. If this second round is also lost to the gunner, the tank commander continues with the adjustment, making necessary deflection and range changes to destroy the target.

(2) When the initial range to the target is determined by a less accurate means (estimation, etc.), the standard range change depends on the determined range. If the range is 1,500 meters (yards) or less, the standard range change is ADD or DROP 200 meters (yards) ; if the range is over 1,500 meters (yards), the standard range change is ADD or DROP 400 meters (yards). The procedure for applying the standard range change is the same as in (1) above.

e. Large Range Error. If an extremely large error (more than 400 meters) is made in the initial range, the tank commander may announce a range element—*for example,* RANGE, TWO FOUR HUNDRED—or he may cease fire and then issue a new initial fire command to insure target identification as well as correct range.

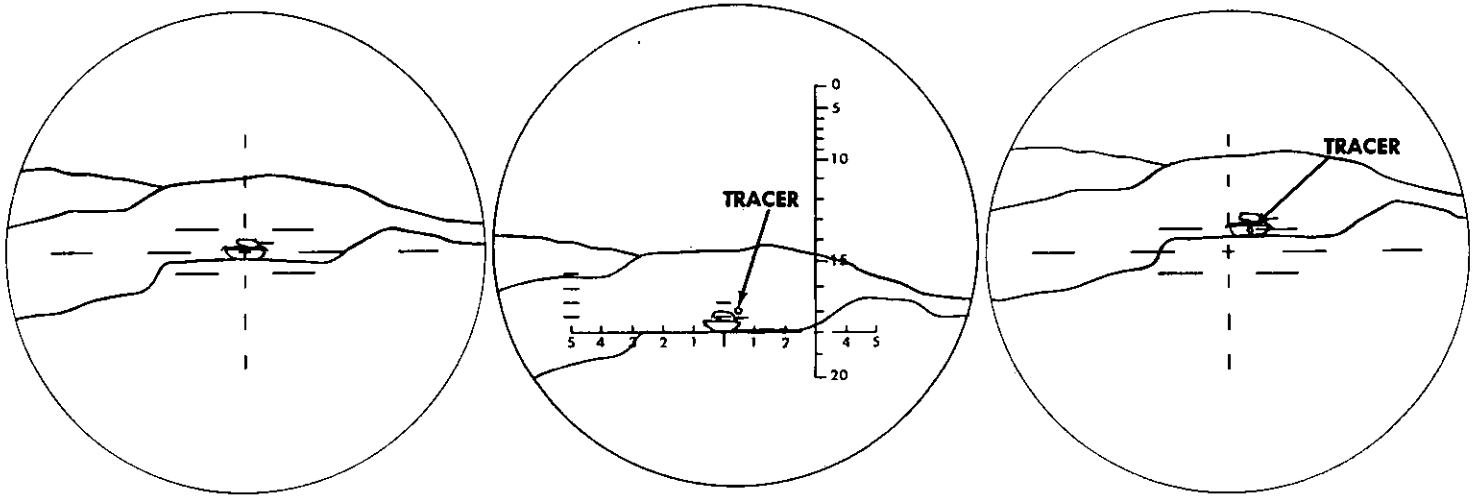
f. Target, Doubtful, and Lost Rounds.

(1) Regardless of the means of determining range, if the tank commander senses the round as *target, doubtful,* or *lost,* the rule of the standard range change does not apply. With a sensing of *target* or *lost,* the tank commander can make any range change that he feels is necessary to destroy the target and with a sensing of *doubtful,* no range change is made.

(2) When the gunner fails to observe the round, he announces LOST. If the tank commander fails to observe the round, he also announces LOST and issues a subsequent fire command. Depending on the circumstances, he may not change the range, or he may give a range change to bring the next round to where it can be observed.

114. Application of the Alternate Method of Sensing Adjustment (fig. 62)

The tank commander issues his subsequent fire command. The gunner applies the correction by use of his direct-fire sight. He makes deflection corrections by use of the lead lines, moving the gun left or right the announced number of mils. He makes range



GUNNER'S INITIAL SIGHT PICTURE — **TANK COMMANDER'S SENSING** — **GUNNER'S CORRECTED SIGHT PICTURE**

Figure 62. Application of the alternate method. The tank commander mentally senses the first round as ***over, two right****; announces OVER, and commands LEFT TWO, DROP TWO HUNDRED, FIRE. The gunner applies the correction by moving the gun 2 mils left and 2 mils down when firing ammunition with a muzzle velocity of less than 3,500 feet per second.*

changes by use of the range lines, moving the gun up or down to change range by the announced number of meters (yards). When using a sight with a ballistic reticle, he makes this change by direct application. The range lines of nonballistic reticles are graduated in mils; therefore, when using this type of reticle, he must convert the range change to mils by use of the C factor. (The C factor for any ammunition is the number of mils of change in elevation necessary to move the strike of the projectile 100 meters or yards.) When ammunition with a muzzle velocity of 3,500 feet per second or less is fired, a 100-meter (yard) change is equivalent to a C factor of 1 mil for tank gunnery purposes. When ammunition with a muzzle velocity in excess of 3,500 feet per second is fired, a 100-meter (yard) change is equivalent to a C factor of ½ mil for tank gunnery purposes.

Note. Projectiles traveling faster than 4,500 feet per second may have as much as a 200-meter (-yard) change for ½ mil; however, vertical change is the primary consideration; therefore, the guide for conversion listed above is still applicable.

115. Repeating and Correcting Subsequent Fire Commands

a. Repeating Commands. The procedure for repeating elements of subsequent fire commands is the same as for initial fire commands (par. 103). The crewman requests a repetition by announcing the elements as a question, and the tank commander repeats only the elements requested. For example, if the gunner announces RANGE? the tank commander repeats ADD TWO HUNDRED.

b. Correcting Commands. To correct an error in a subsequent fire command, the tank commander announces CORRECTION and then issues an entire corrected command. The sensing is not repeated unless it was announced incorrectly.

Example.

Announced Sensing:	OVER	DOUBTFUL	SHORT
Command:	RIGHT THREE	LEFT TWO	DROP FOUR HUNDRED
	ADD TWO HUNDRED	FIRE	CORRECTION
	CORRECTION	CORRECTION	OVER
	RIGHT THREE	RIGHT TWO	DROP FOUR HUNDRED
	DROP TWO HUNDRED	FIRE	FIRE
	FIRE		

c. Correcting Errors by Adjustment. If the gunner fires before an error in the initial or subsequent fire command is corrected, the correction is made by adjustment of fire. Error in the deflection or range elements can be corrected by either burst-on-target or alternate method. An extreme range error that would preclude use of burst-on-target or standard range change can be corrected by a new range element. However, what appears to be a large range error may be a failure to identify the target or be some other failure. In such cases it is best to cease fire and issue a new initial fire command.

116. Changing Ammunition (Fuze)

During firing, it may be necessary to designate a different type of ammunition or fuze because of an error in the ammunition element of the initial fire command or a change in the nature of the target. For example, if a round of shot has penetrated a pillbox or heavy masonry building and the tank commander desires to fire HE through the opening, he commands FIRE HE. The loader immediately loads HE and announces HE UP. He will continue to load the new ammunition until he hears CEASE FIRE or another command. The gunner notes where the shot round appeared on his sight reticle in relation to the target. He then indexes HE in order to compensate for the difference in super elevation between shot and HE, re-lays with the noted point on the opening, and fires. The same procedure is used to change a fuze setting. For example, to change from fuze superquick to fuze delay, the tank commander commands FIRE HE DELAY. Normally, a chambered round will be fired even though a change in ammunition or fuze is necessary (par. 104*c*).

117. Non-Sensing Adjustment

a. The use of the *sensing* versus the *non-sensing* method of adjustment must be predetermined for each type of ammunition available in the basic load (par. 109). Knowing by previous firing experience that a round cannot be sensed because of its high velocity, the gunner, upon hearing this type of ammunition announced in the fire command, will, during the target engagement, without command, use the non-sensing method, if adjustment is necessary. The same procedure is used regardless of the method used to determine range. For this type ammunition, ½ mil is used to make a 100-meter (-yard) range change with a nonballistic reticle (par. 114). This method of adjustment requires the firing of at least two or three rounds, depending on the circumstances. The adjustments are made by the gunner, using his direct-fire sight (fig. 63), as follows:

(1) The first round is fired in the same manner as for sensing adjustment, i.e., the aiming cross (nonballistic

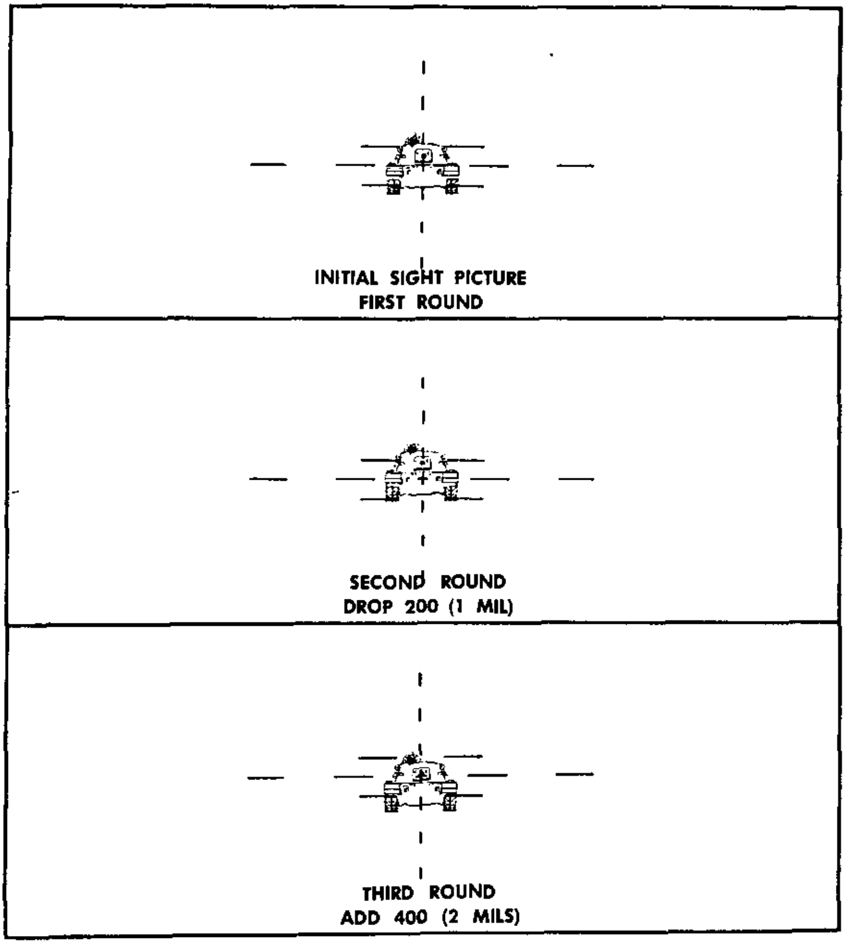


Figure 63. Non-sensing method of adjustment (stationary target).

reticle) or appropriate range line (ballistic reticle) is laid on the center of vulnerability of the target.

(2) If a first-round hit is not obtained, the gunner drops 200 (1 mil) and fires a second round.

Note. Firing experience has shown that whenever a round can be observed (par. 109*c*) it is usually short; therefore, if nothing is observed, it is most apt to be *over*.

(3) If a second-round hit is not obtained, the gunner adds 400 (2 mils) from the second round fired, and fires a third round.

b. Even when using the non-sensing method of adjustment, target hits usually can be sensed, especially hits on metallic targets.

Note. If other than target hits can be *sensed*, a sensing method of adjustment should be used for that type ammunition.

When the target has been hit, the tank commander will command either TARGET—FIRE or TARGET—CEASE FIRE, depending on whether the target has been destroyed. Upon hearing the command TARGET—FIRE, the gunner uses the sight picture that produced the hit and continues to fire until the command CEASE FIRE is given. If a target hit must be adjusted to a more vulnerable part of the target, it is accomplished by moving the point of the reticle that coincides with the hit, to the center of vulnerability or applying the alternate method of sensing adjustment (correcting from the hit).

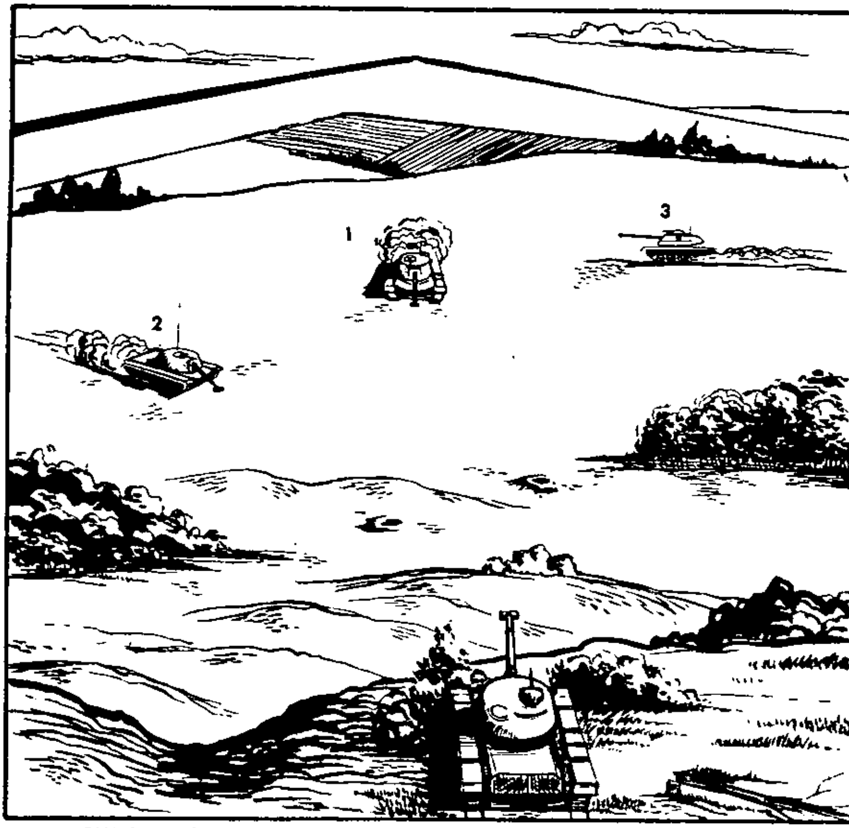
c. If the first round is *observed* as short by either the gunner or the tank commander, the appropriate change to the adjustment drill will be made, i.e., add first instead of drop. If the gunner observes the round, he will reverse the direction of the adjustment if the observation so dictates and indicate the change by announcing SHORT. If the tank commander *observes* a short not observed by the gunner, he will announce SHORT, and this indicates to the gunner that he must add instead of drop for the second round. If observation dictates that the direction of the adjustment is reversed, only two rounds will be fired (unless the target is hit but not destroyed).

d. The flater trajectory of this type ammunition makes it more accurate than ammunition of lower velocities, and employing all rounds in the drill gives almost complete assurance of a hit somewhere on the target. However, if for some reason a hit is not obtained using this method of adjustment, the tank commander should redetermine range and fire again or select another firing position from which more of the target is visible.

Section V. ADJUSTMENT OF FIRE ON MOVING TARGETS

118. Apparent Speed

For tank gunnery purposes, a moving target is one that has apparent speed. Apparent speed (fig. 64) is movement of a target across the line of sight (direct-fire sight). Targets that move across the line of sight, either at a right angle or diagonally, have apparent speed as the turret must be traversed to keep up with the movement of the target. Targets that move directly toward or away from the tank do not have apparent speed and are not engaged as moving targets. Such targets may require a slight elevation or depression of the tube to maintain the aiming cross on the center of vulnerability, but otherwise are engaged in the same manner as are stationary targets.

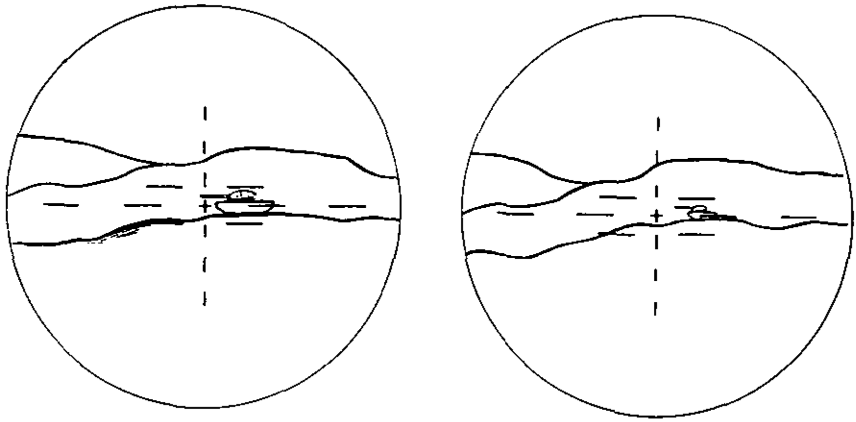


TANKS 1, 2, AND 3 ARE MOVING AT 10 M.P.H. TANK 1 HAS NO APPARENT SPEED.
TANK 2 AND 3 BOTH HAVE APPARENT SPEED, WITH TANK 3 HAVING THE GREATER.

Figure 64. Apparent speed.

119. Leading

If the gunner fires a round with the gun aimed directly at a moving target, the target will move out of the path of the projectile, causing it to miss the target. To compensate for this movement, the gun is aimed ahead of the target so the projectile and target will meet. This technique is called leading (fig. 65). The gunner measures lead by use of the lead lines on the reticle of his direct-fire sight. One lead equals 5 mils and is measured from the center of vulnerability. Moving targets are engaged initially with one lead, regardless of range or speed. As the mil is a unit of angular measurement, range has no effect on lead. Speed does affect lead; however, one lead is usually sufficient to obtain hits on targets moving at battlefield speeds (5–15 m. p. h.). Therefore the rule of taking one lead initially for all moving targets is a practical solution to a problem that would otherwise



Moving target—range 1,000 meters (yards). Sight picture for one lead.

Same moving target—range 2,000 meters (yards). Sight picture for one lead. Target appears smaller due to greater range, but lead is the same.

Figure 65. Leading.

involve such considerations as speed, direction, range, ballistics, and human error. A gunner uses an initial sight picture with one lead when the command to do so is given by the tank commander in the initial fire command.

120. Tracking

To maintain the proper lead, the gunner must cause the movement of the gun to keep pace with the movement of the target. This manipulation is called tracking and is a combination of traversing and changing elevation to maintain the proper sight picture. The gunner must track with a smooth, continuous motion, maintaining a constant sight picture before, during, and after firing so that correct sensings can be made and necessary adjustments accomplished. He must not stop the movement of the gun as he fires, or attempt to "ambush" the target (moving ahead of the target, stopping, and firing when the target reaches the proper lead on the sight reticle). When firing hypervelocity rounds or when there is a great amount of obscuration, the gunner may temporarily lose sight of the target, but he should continue to track at the same speed and then take the correct sight picture as soon as the target is again visible.

121. Initial Fire Command for Moving Targets

Initial fire commands are the same as those used for engaging stationary targets, except that a lead element is included. Crew firing duties also are similar to those given for firing at stationary targets; however, additional coordination is required between the tank commander and the gunner to insure continuous tracking of the target. If the tank commander has laid the gun on the target before it has been identified by the gunner, he must track the target until the gunner announces IDENTIFIED and takes control of the turret and gun. On tanks equipped with a stereoscopic range finder, the gunner then tracks with no lead while ranging is accomplished by the tank commander. On the command FIRE, the gunner takes a sight picture with one lead, if this has not already been accomplished, continues to track, and fires. If range is announced or indexed by the tank commander without ranging, the elements of the command will be issued without pause. After identifying the target and receiving the command FIRE, the gunner will track, apply one lead, and fire. Depending on the situation and equipment used, the initial fire command may contain 5, 6, or 7 elements.

Examples.

GUNNER	GUNNER	GUNNER
SHOT	HE	SHOT
TANK	ONE TWO HUNDRED	EIGHT HUNDRED
ONE LEAD	TRUCK	TRAVERSE RIGHT—STEADY—ON
FIRE	ONE LEAD	TANK
	FIRE	ONE LEAD
		FIRE

122. Primary Method of Sensing Adjustment, Moving Target

The primary method of sensing adjustment for moving targets is burst-on-target, which is applied in a manner similar to burst-on-target for stationary targets (par. 112). The primary method normally is used when the gunner can sense the rounds fired. The gunner fires while tracking with the correct lead and continues to track so that a proper sensing and necessary adjustment to the center of vulnerability can be made. The gunner continues to fire without command until the tank commander commands, CEASE FIRE or otherwise assumes control of the firing. Examples of burst-on-target, showing the gunner's application with both types of sight reticle, appear below.

a. Situation 1, Nonballistic Reticle; Target, Moving Tank.

(1) The gunner immediately checked the lay of the gun after firing. This round passed over and behind the moving target (fig. 66).

(2) The gunner mentally noted the point on the sight reticle

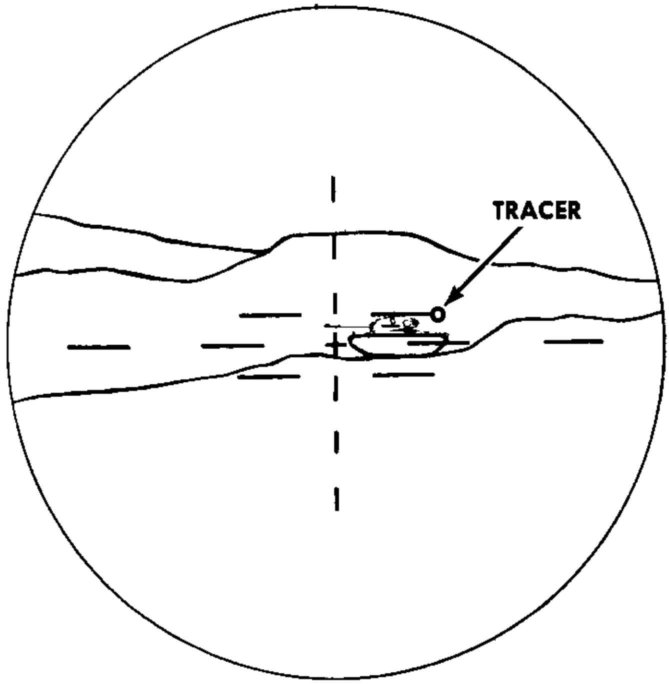


Figure 66. Situation 1, first round.

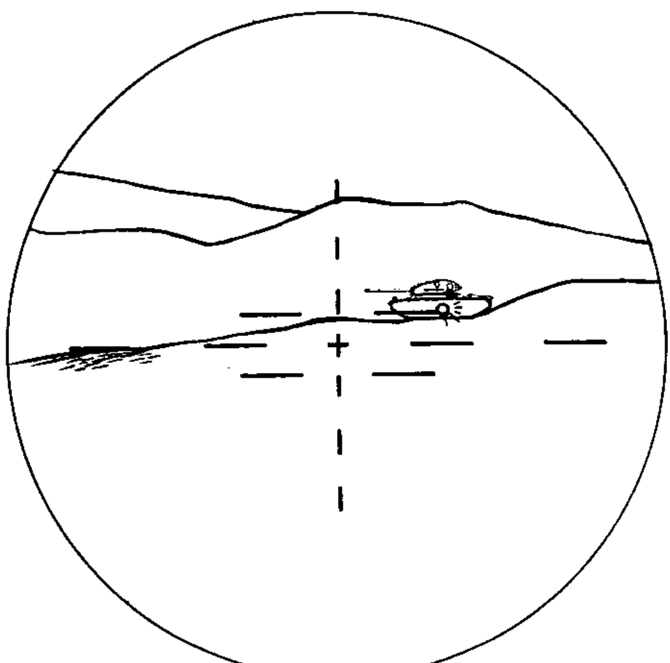


Figure 67. Situation 1, second-round hit.

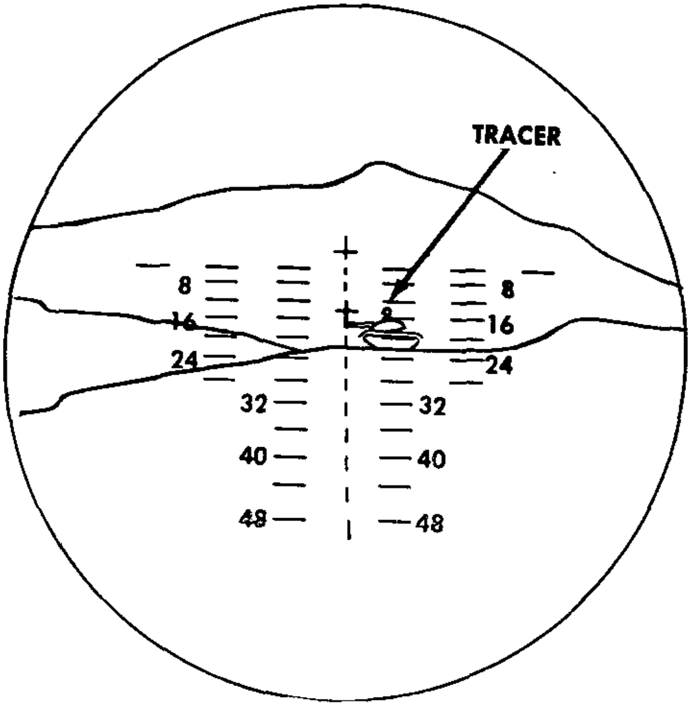


Figure 68. Situation 2, first round.

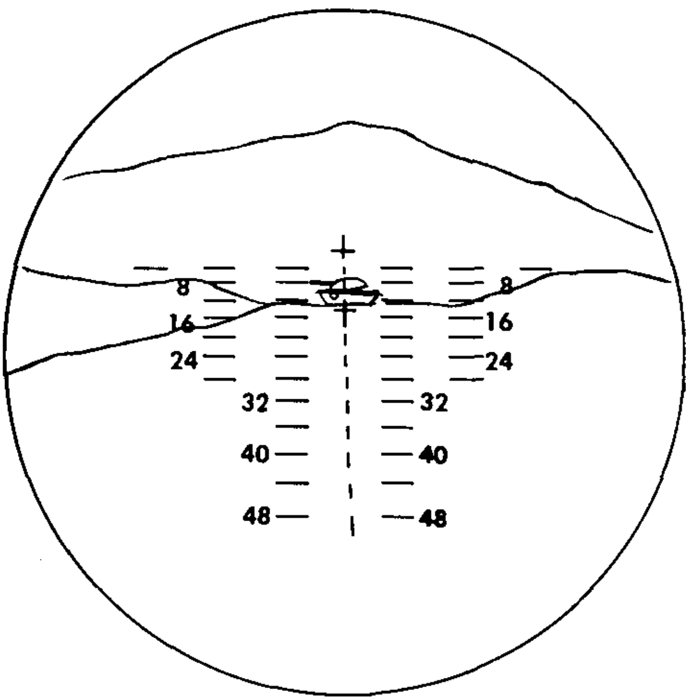


Figure 69. Situation 2, second-round hit.

where the tracer appeared and, with the gun controls, moved that point directly to the center of vulnerability of the target. Without command, he fired again while tracking with the new sight picture, and obtained a target hit (fig. 67).

b. Situation 2, Ballistic Reticle; Target, Moving Tank.

(1) The gunner immediately checked the lay of the gun after firing. This round was correct for lead but over in range (fig. 68).

(2) The gunner mentally noted the point on the sight reticle where the tracer appeared and, with the gun controls, moved that point directly to the center of vulnerability. He fired again and obtained a target hit (fig. 69).

123. Alternate Method of Sensing Adjustment, Moving Target

a. General. The alternate method of sensing adjustment is the tank commander's means of adjusting fire when the gunner cannot effectively apply burst-on-target. The conditions under which this method is used are the same as those for stationary targets (par. 113).

b. Subsequent Fire Command. The tank commander employs the alternate method by announcing his range sensing and issuing a subsequent fire command. The announced sensing precedes the subsequent command. Range corrections are announced as prescribed for stationary targets, and the standard range change applies. A lead correction is announced as a change in leads rather than in mils and is made in multiples of one-half lead. For example, if a round passes from 4 to 6 mils behind the center of vulnerability of a target, the tank commander commands ONE MORE, and the gunner increases the lead accordingly. If the round passes 2 or 3 mils in front of the center of vulnerability, the tank commander commands ONE-HALF LESS, and the gunner decreases the lead. ONE-HALF means one-half of 1 lead, or $2\frac{1}{2}$ mils. The subsequent fire command may consist of 1, 2, or 3 elements. If all elements are required, they are issued in the following sequence: range, lead, and execution.

Examples.

Announced Sensing:	OVER	SHORT	DOUBTFUL
Command:	DROP TWO HUNDRED ONE-HALF LESS FIRE	ADD FOUR HUNDRED FIRE	ONE MORE FIRE

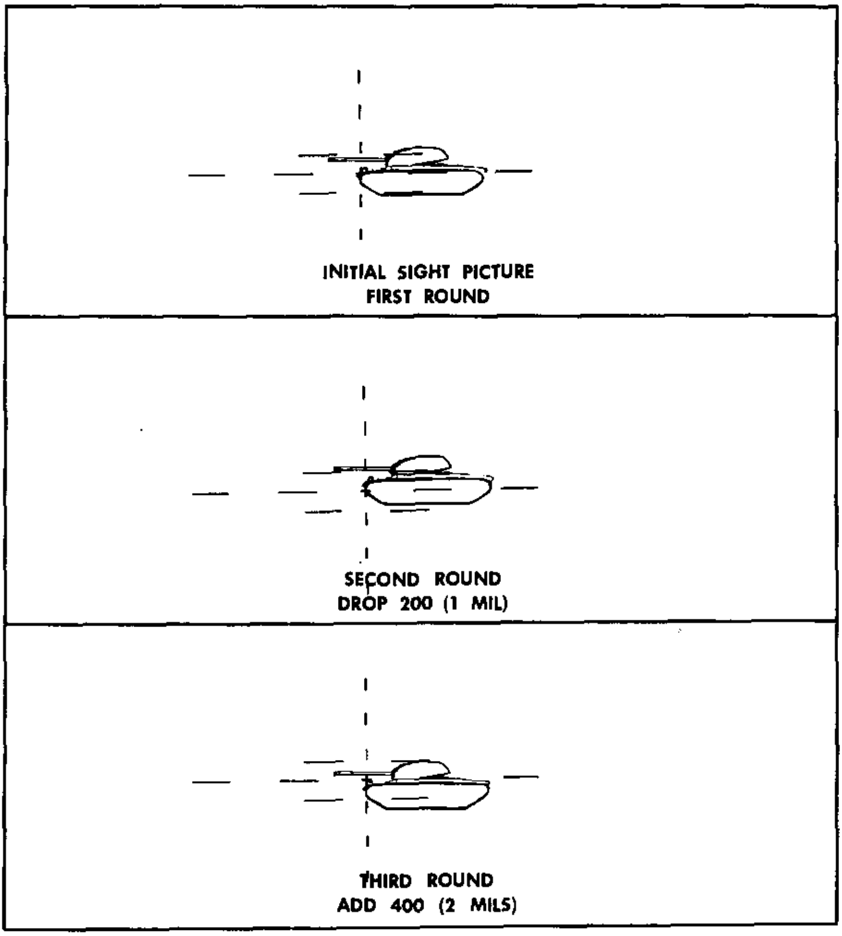


Figure 70. Non-sensing method of adjustment (moving target).

124. Non-Sensing Adjustment, Moving Target

Non-sensing adjustments are the same for moving targets as for stationary targets (par. 117) except for the application of lead (par. 119). During the firing of the non-sensing method of adjustment at moving targets, the initial round, and, if necessary, subsequent rounds corrected for range, are fired while maintaining a one-lead sight picture (fig. 70).

Section VI. FIRING TANK MACHINEGUNS

125. General

The tank machinegun is extremely flexible in that it can be fired effectively against a wide variety of targets from either a

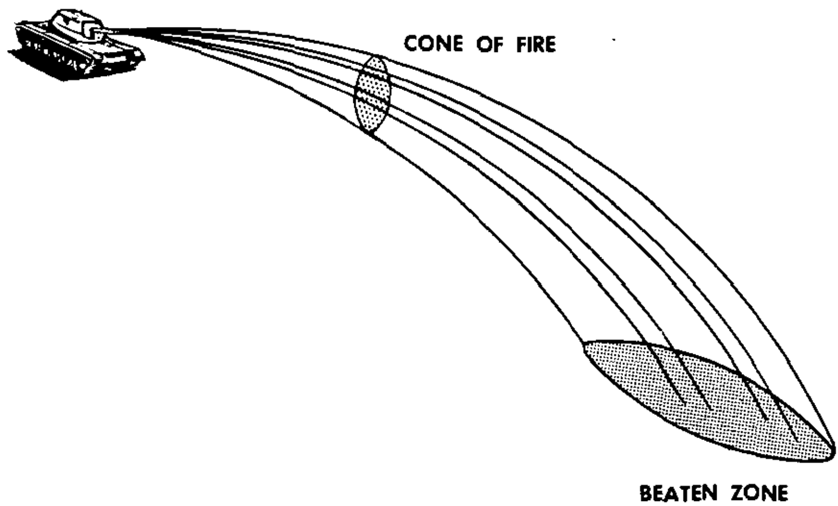


Figure 71. Cone of fire and beaten zone.

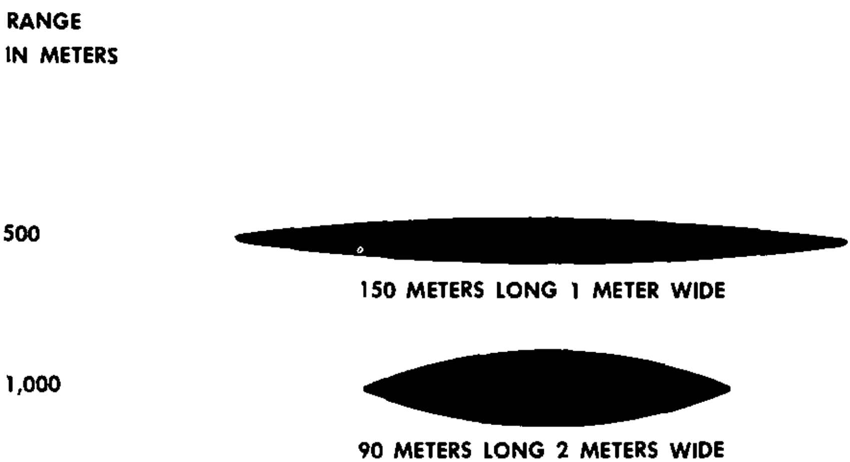


Figure 72. Approximate dimensions of beaten zones, coaxial machinegun.

moving or stationary tank in offensive or defensive situations. The chief characteristics of machinegun fire are dispersion and high rate and volume of fire. Volume of fire, area coverage, and a killing zone from gun to target are obtained by firing in bursts. Due to dispersion, the bullets of each burst do not follow the same trajectory, but spread to form characteristic patterns in the air and on the ground. The pattern in the air is known as the cone of fire, and the pattern on the ground is the beaten zone (fig. 71). The cone of fire is oval in shape, while the beaten zone forms a long and narrow elliptical pattern (fig. 72). The machinegun is a very effective weapon to use against troops and soft or thin-skinned targets such as crew-served weapons, lightly constructed cover, and unarmored or lightly armored vehicles. While it has little destructive effect against tanks and fortifications, machinegun fire will cause tank crews to "button up."

126. Classes of Machinegun Fire

There are three general classifications of machinegun fire (fig. 73); they are based on characteristics of the weapon, nature of the target, and the terrain within the sector of fire. All machinegun fire belongs to a combination of these three classifications, which can be further subdivided as follows:

a. Classes of Fire With Respect to the Gun.

(1) *Fixed fire.* Fire delivered on a point or small area target. The depth of the beaten zone must include the target.

(2) *Searching fire.* Fire distributed in depth by successive range changes of the gun. It is used against targets too deep to be included in the beaten zone of fixed fire.

(3) *Traversing fire.* Fire distributed in width by successive changes in the direction of the gun. A burst of fire may be delivered after each change in direction, or a continuous burst may be fired while traversing through the target. (Traversing and searching fire may be combined to engage targets of considerable width and depth).

b. Classes of Fire With Respect to the Target.

(1) *Frontal fire.* Fire delivered at right angles to the front of a target.

(2) *Flanking fire.* Fire delivered against the flank of a target.

(3) *Oblique fire.* Fire delivered so that the long axis of the beaten zone is oblique to the long axis of the target.

(4) *Enfilade fire.* Either frontal or flanking fire in which the long axis of the beaten zone coincides or approximately coincides with the long axis of the target.

c. Classes of Fire With Respect to the Ground.

(1) *Plunging fire.* Fire in which the angle of the cone of fire to the slope of the ground is such that the killing zone is practically confined to the beaten zone. Because of this angle, the beaten zone is materially shortened. Plunging fire occurs when the gun is firing from high to low ground, into abruptly rising ground, or at long ranges.

(2) *Grazing fire.* Fire in which the center of the cone of fire does not rise above the height of a standing man. A gun fired over level or uniformly sloping ground produces grazing fire at ranges up to approximately 700 meters.

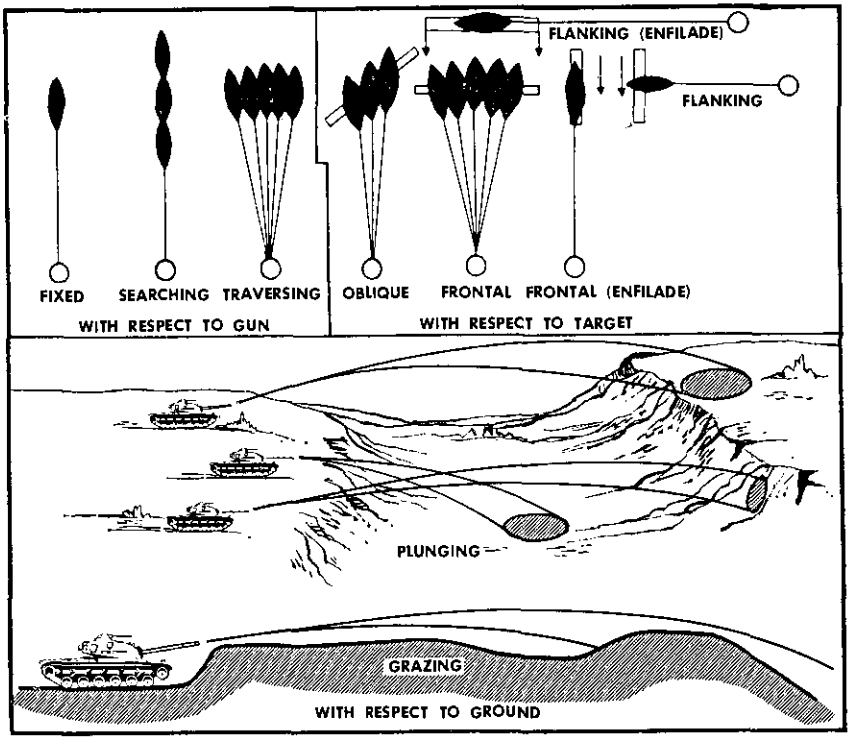


Figure 73. Classes of fire.

127. Tactical Employment of Machineguns

The ideal situation for machinegun employment is when targets can be engaged from the flank by grazing, enfilade fire. In the defense, tanks are sited where they can best fire the main gun on avenues of approach for enemy armor, although such positions may not offer an opportunity to use the most effective class of tank machinegun fire. In the offense, rapidly changing tactical situations dictate the method of employment. Tank machineguns are primarily offensive weapons and normally are employed against targets of opportunity. Their flexibility and high volume of fire make them very effective against surprise targets that must be rapidly engaged in mobile situations. In the attack, tanks supporting by fire normally employ the main gun. Maneuvering tanks use their main gun as they work toward the objective, but usually fire their machineguns in the assault.

128. Coaxial Machinegun

a. The coaxial machinegun is fired in bursts of 20 to 25 rounds for adjustment of fire and to accomplish target destruction. Once fire has been placed in the target area, the gun is fired while traversing and searching, when necessary, to obtain area coverage until the target is destroyed. As tracer burnout occurs at approximately 900 meters (1,000 yards), the coaxial machinegun normally is not fired at targets at greater ranges because adjustment of fire at these ranges is ineffective. Beyond the range of tracer burnout of coaxial machinegun ammunition, the caliber .50 machinegun or main gun should be used. When fire control instruments that do not have a machinegun setting are used, ammunition with the lowest muzzle velocity is indexed.

b. If there is no separate sight for the coaxial machinegun, the main gun sight must be used. Adjustment of fire is accomplished in the manner described in *a* above, no matter what sight is used. The fire command for engaging targets with the coaxial machinegun is the same as for the main gun except for the weapon element (par. 95).

129. Cupola- or External Turret-Mounted Machinegun

The cupola- or external turret-mounted machinegun is employed by the tank commander against aircraft, lightly armored vehicles, and fortifications, as well as the type of targets normally engaged by the coaxial machinegun. A fire command is not issued because it is fired by the tank commander, but CALIBER FIFTY is announced to inform other crew members that it will be fired. Against aerial targets, the tank commander fires a continuous burst as long as the aircraft is within range, moving the tracer stream into the target by leading and tracking. Against ground targets, the gun is fired in the same manner as is the coaxial machinegun but in bursts of from 10 to 20 rounds. Tracer burnout for caliber .50, armor-piercing incendiary tracer (APIT), occurs at approximately 1,600 meters (1,750 yards) and for caliber .50, tracer, at approximately 2,250 meters (2,450 yards).

Section VII. FIRING FROM A MOVING TANK

130. General

Firing the main gun from a moving tank, unless the gun is stabilized, is inaccurate and difficult, but it may become necessary in the final assault, when ambushed, or when surprised. Machineguns, however, can be effectively employed from moving tanks. The effectiveness of machinegun fire is enhanced by the psychological factor of a moving tank firing on the objective.

131. Crew Teamwork When Firing on the Move

Successful firing from a moving tank requires crew coordination and teamwork. The driver must keep the tank as steady as possible. The gunner must learn the feel of the tank and counter its movement by manipulating the gun controls to maintain the correct sight picture. Guns normally are fired with battlesight (par. 138) or with an estimated range.

132. Firing the Coaxial Machinegun on the Move

Tanks maneuvering against the enemy should not stop to fire the coaxial machinegun unless the target is dangerous and good defilade is available. If caught in the open, tanks should continue to move toward the enemy, presenting their frontal armor to the enemy fire. Within effective range, the coaxial machinegun is the best weapon for engagement of soft targets from a moving tank. Fire is adjusted by observation of the tracer stream as in firing from a stationary tank. Aiming techniques vary with the direction of movement.

a. Firing to the Front and Rear. When moving toward a target, gunner adjusts fire to the near edge of the target. He then allows the movement of the tank to move the fire through the target in depth while he traverses to cover the target width. When moving away from a target, he adjusts fire to the far edge.

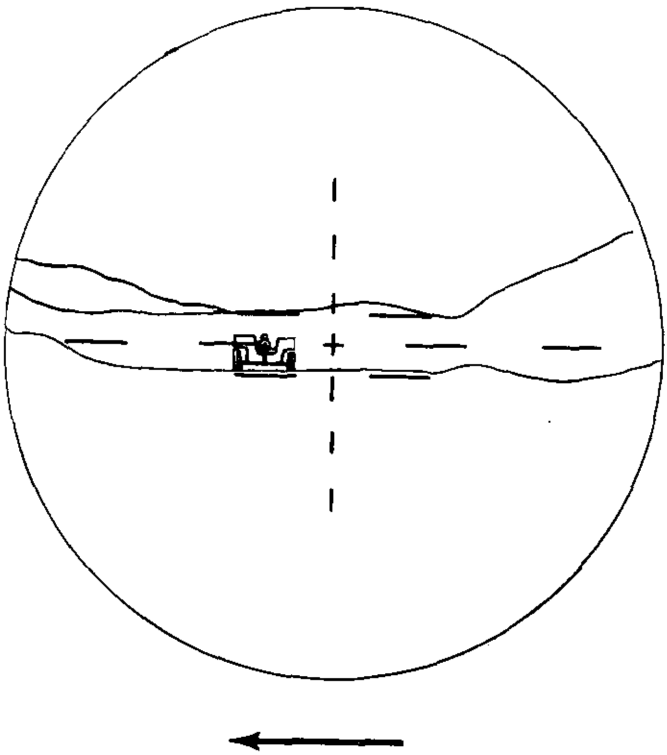
b. Firing to the Side. When firing to the side from a moving tank, the gunner adjusts fire to the near edge of the target. He then allows the movement of the tank to move the fire through the target width while he elevates and depresses to cover the target depth.

133. Firing the Cupola- or External Turret-Mounted Machinegun on the Move

The caliber .50 machinegun affords greater firepower than the coaxial machinegun at greater ranges; however, the accuracy of this fire is affected by the type of mount. Fire is adjusted as in firing from a stationary tank, and the technique of covering the target area is the same as for the coaxial machinegun (par. 132).

134. Firing the Main Gun on the Move

In training, firing the main gun from a moving tank is prohibited unless the gun is stabilized. However, under combat conditions, it may be so fired in an emergency. Due to the inaccuracy of this fire, the purpose is neutralization rather than destruction. For this reason, HE or HEP normally is used against all targets. A certain amount of aim-off is required to compensate for the movement of the tank.



DIRECTION OF MOVEMENT OF FIRING TANK

Figure 74. Reverse lead.

a. Firing to Front and Rear. When the tank is moving toward or away from a target, its pitching (up and down) motion will cause the gun to have greater vertical motion than lateral motion. As the gun moves upward, the gunner fires when the aiming cross passes the bottom of the target; as the gun moves downward, the gunner fires when the aiming cross passes the top of the target. This is known as vertical aim-off. The gunner adjusts fire by taking more aim-off if he is firing too late, less aim-off if he is firing too early.

b. Firing to the Side. When the gunner is firing to the side from a moving tank, the forward and pitching motion of the tank will cause the gun to have greater lateral motion than vertical motion. The greatest lateral motion is in the direction of the tank's forward motion. This causes the gun to move through the target and gives a lateral motion to the projectile as it is fired. To compensate for this, the gunner fires with a reverse lead (5 mils) (fig. 74). He adjusts fire by taking more lead if he is firing too late; less lead if he is firing too early.

Section VIII. TECHNIQUES OF FIRING

135. General

To obtain the maximum accuracy in firing, certain techniques of firing must be employed in conjunction with target engagements. These techniques are effective only if proper sight adjustment has been accomplished (pars. 51–58) and all fire control equipment has been properly placed in operation. For details on fire control equipment of a particular tank and prepare-to-fire checks, refer to the appropriate technical or field manual. For techniques of night firing, see paragraph 157*b*.

136. Firing Techniques

a. Preparation of Sights for Firing.

(1) Position properly all adjustable headrests for all sights for individual use. Taking sight pictures with the head in the same position each time reduces parallax errors (par. 58*c*) and a properly adjusted headrest assists in meeting this requirement.

(2) Make the proper diopter adjustment for the eyepieces of each sight, if adjustable, and establish the correct interpupillary distance for all binocular sights.

(3) On sights with selectable or attachable filters, use the proper filter to assist in sighting, sensing, and adjusting fire (par. 49*b*).

b. Prevention of Uncontrolled Movements of Tank Gun and Sights.

(1) After loading, do not move the gun by inadvertently pressing against or leaning on it. In addition to the danger involved, such action can also result in an incorrect lay of the gun. When mounting the tank over the front slope with the gun to the front, do not use the gun as a brace. This will contribute to loss of the definite relationship between the gun and the sight, established during sight adjustment. It can also result in an injury if the gun is hot.

(2) After sight adjustment, do not unnecessarily touch the sights or linkage. Too much pressure on this fire control equipment will cause inaccurate lays. Even pressing the head too hard against the headrest on a sight can result in a deviation in a lay of several mils. One of the most common and serious errors in this respect is for the tank commander on range finder equipped tanks to place his hands unnecessarily on the body of the instrument when

sighting or ranging or to aid himself in moving up to a position to use his binocular.

c. Sensing Tracer Equipped Ammunition. When sensing tracer ammunition, concentrate on the target and not on the tracer. All projectiles describe an arched trajectory (some are much more pronounced than others) and even though those fired from the tank guns are relatively flat, their tracers will appear at various heights while in flight. Concentrating on the target during firing will result in more correct sensings.

d. Accurate Laying and Firing.

(1) When laying the gun, be as precise as possible and make each lay by moving in one direction (elevation and deflection). The direction of the lay will not necessarily be the same each time, but avoid having to change the direction to accomplish the lay (especially during the last few mils of movement). Laying in one direction compensates for any lost motion or backlash in the linkage and results in a more accurate lay.

(2) As in zeroing, ammunition used during a target engagement should be from the same lot, if possible. Also, adjustments in firing must be performed rapidly (within time limits prescribed for qualification firing) so the propellant of the round chambered does not become heated to the extent that it causes excessive variation in round-to-round performance. When firing a type of ammunition that discards part of its projectile in flight, disregard these parts as they will create a false sensing.

(3) When firing using a trigger on the power control handle, do not move the gun when squeezing the trigger by inadvertently moving the handle.

Section IX. TECHNIQUES OF TARGET DESTRUCTION

137. General

A variety of weapons and methods of adjustment are required to destroy various types of targets. Because no two combat situations are exactly alike, no single technique of engaging targets will fit every occasion. As targets differ in importance, nature, size, location, and actions, tank crewmen (particularly the tank commander) must be quick to recognize these differences and react accordingly. As a result of combat experience, certain techniques of target destruction have been devised to obtain rapid target destruction. They are based on a thorough knowledge of tank gunnery principles, vulnerability of targets, and the destructive capabilities of tank guns and ammunition.

138. Battlesight

Battlesight is a combination of a predetermined range and ammunition setting (both indexed in the fire control system) with the specified ammunition loaded. It is employed against dangerous surprise targets and rapidly fleeing targets. The range and ammunition are determined by the unit commander (normally the company or troop commander, but also by the platoon leader or even a tank commander when the situation dictates) as the most effective combination for destruction of the most dangerous target expected to be encountered in the immediate battle area. Battlesight is changed as necessary; it will vary according to available information of the enemy, terrain, and weather. The range is determined by previous experience or reconnaissance. The ammunition selected normally depends on the probability of tank or antitank opposition. An *example* of a battlesight setting is a range of 1,000 meters (yards) and armor-defeating ammunition. This range-ammunition combination gives a high hit probability on tanks up to approximately 1,200 meters (yards). The effective use of battlesight depends on rapid and accurate laying, with emphasis on speed. This means that both the main gun and machineguns are kept loaded. With guns loaded and sights set, a tank crew should have an advantage on a dangerous target. The flat trajectory of projectiles fired from the tank gun gives a high probability of a first-round hit, even though the target is not at exactly the range indexed in the fire control equipment. If a hit is not obtained, the appropriate method of adjustment will be applied. Should the target be at a range that is considerably in excess of the battlesight range, the tank commander will *not* employ battlesight; instead he will issue an appropriate fire command, with an ammunition element to indicate that battlesight will not be used. With battlesight, the following specific techniques are used:

a. Initial Fire Command. An example of a battlesight command is:

Alert	GUNNER
Ammunition and range	BATTLESIGHT
Description	TANK
Execution	FIRE

Note. Should a different type of ammunition be required to destroy the target, even though it is within battlesight range, a battlesight fire command will be issued to fire the chambered round and this will be followed immediately by a subsequent fire command to change ammunition, e.g., FIRE HE.

b. Actions and Adjustments. As ammunition and range have been previously indexed into the fire control equipment, the gunner merely lays on the center of vulnerability of the target and fires on command. Adjustment of subsequent rounds and actions of the tank crew are in accordance with standard procedures. The loader will continue to load the battlesight ammunition until the tank commander gives CEASE FIRE or changes ammunition. Once a round has been chambered, it should be fired, despite a subsequent change in ammunition, and the change made for the next round.

139. Firing by the Tank Commander

Because of his command responsibilities, the tank commander normally will not fire the main gun. However, in situations where target recognition by the gunner is difficult, it may be necessary for the tank commander to take over the firing. For example, due to the position of the turret, the tank commander may be the only one to observe the flash of a well-concealed antitank gun when it fires. The chances are remote that the gunner will be able to immediately identify the target, and the seconds lost in attempting to "talk" the gunner onto the target might result in destruction of the tank. To indicate that he will fire, the tank commander, after issuing all the necessary elements of the command up to the description, and the gunner fails to identify the target, announces FROM MY POSITION, then ON THE WAY just before firing. The tank commander fires the initial round and continues to fire subsequent rounds until the gunner can positively identify the target. As soon as the gunner can identify the target he will announce IDENTIFIED, and the tank commander, by announcing FIRE, can then allow him to fire. Announcing FROM MY POSITION a second time indicates that the tank commander will complete target destruction. Because firing keeps the tank commander from his other duties, he should fire only when the gunner cannot immediately and effectively engage the target.

140. Ricochet Fire

Only impact-type fuzes are used on tank gun ammunition, but against certain targets an airburst is required to hit and destroy it. This is obtained by using a firing technique called ricochet fire. Ricochet fire (fig. 75) is fire delivered at a low angle of elevation, with the burst occurring close above the ground after the projectile has struck and bounced into the air. Ricochet fire is conducted using high explosive ammunition, with the fuze setting changed from superquick to delay, and fired short of the

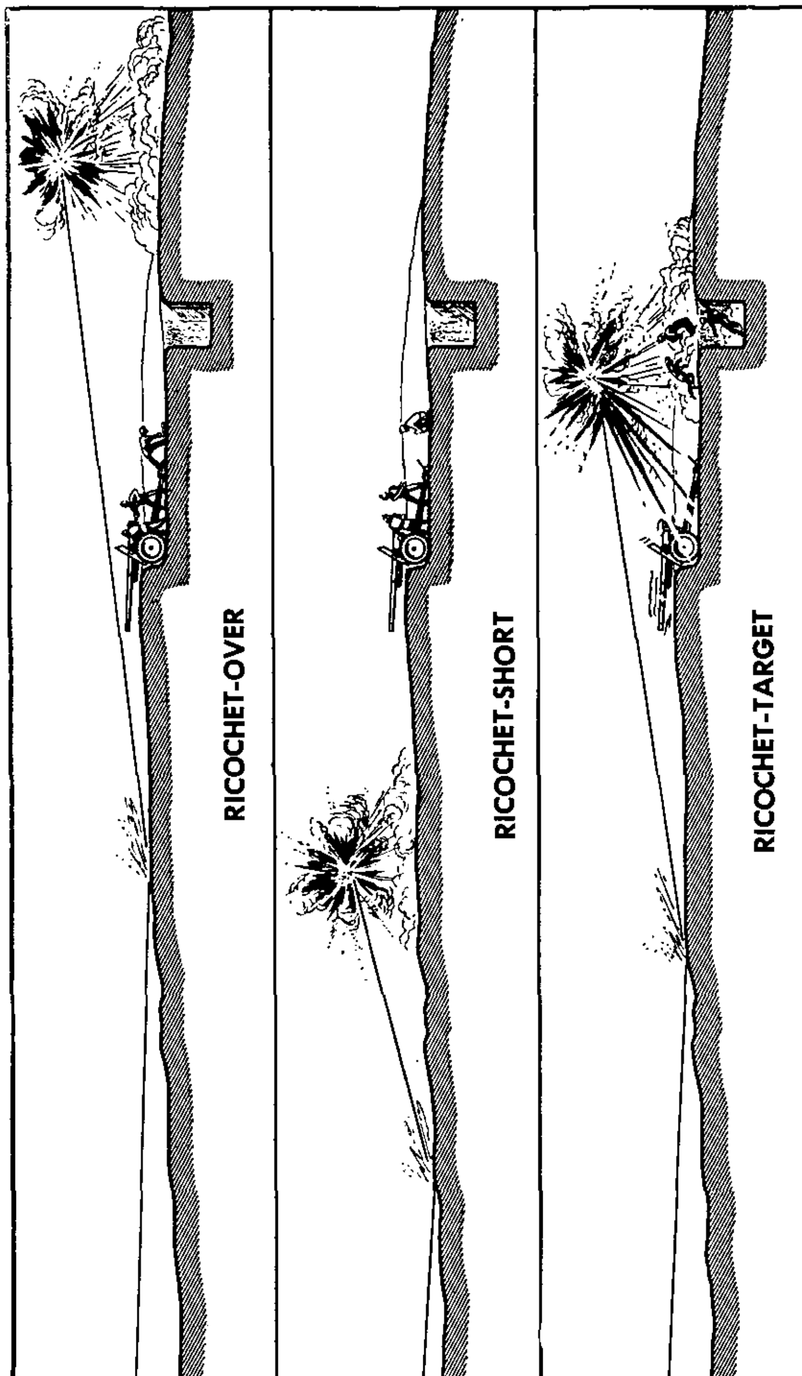


Figure 75. Ricochet fire.

target. When the projectile strikes a relatively hard surface approximately horizontally, the delay action of the fuze will cause an airburst. This fire is employed against dug-in troops and other targets with defilade but little or no overhead cover. To indicate that this type of fire is to be employed, the words RICOCHET FIRE are substituted for the ammunition element. An example of such a command is: GUNNER, RICOCHET FIRE, ANTITANK, FIRE. The alternate method of sensing adjustment is used to adjust the shell fragmentation effect on the ground into the target area. The tank commander is not held to the standard range change, but may make any range change he feels is necessary to obtain target effect. The gunner lays initially on a point approximately 50 meters (yards) short of and on line with the target. From this aiming point, he makes necessary range and deflection corrections as commanded by the tank commander. The aiming point should be a flat hard surface. Ricochet fire cannot be employed when the ground is soft or boggy, because the rounds will bury and explode, giving a mining effect.

141. Dismounted Observer or Two-Tank Method of Adjustment

To increase the accuracy of firing ammunition that cannot be sensed from the firing tank in deliberate or static situations, a dismounted observer or a two-tank method of adjustment can be used (par. 109*c*). In sensing from any position farther than 10 meters from the firing tank, apparent errors in deflection for tracer rounds that are short, or for nontracer rounds that are over or short, must be ignored or an erroneous deflection sensing will be obtained.

a. Dismounted Observer. In the dismounted observer method, the driver or tank commander of the firing tank will dismount to sense and adjust the fire of his tank from a position approximately 10 meters to the flank (windward side). The observer must be able to see the target area from this position and have cover and concealment. Communication between the tank and observer is by use of the external interphone or voice. After the initial round in the engagement is fired, the observer announces a subsequent fire command based on his sensing of the round. Rounds are sensed using the binocular. Adjustment of fire is continued in this manner until the target is destroyed. This method has the disadvantage of not having all crew members mounted for rapidly reverting to a mobile role.

b. Two-Tank Methods. When using a two-tank method of adjusting fire, two tanks form a firing team. The tanks are positioned approximately 50 meters apart and one tank commander is designated the team leader for purposes of deciding target engagements, determining target destruction, and making other decisions. The team leader must issue an initial fire command to initiate the engagement and insure that the location of the target is positively known by the other tank crew. Before employing a two-tank method of adjustment in preference to the dismounted observer method or one tank performing the non-sensing method of adjustment, consideration must be given to the fact that two tanks are required for each target engagement with the firepower of only one tank being employed at a time. Commands and announcements when using two tanks for adjusting fire usually are transmitted by radio and either of the following methods may be used:

(1) *Two-tank burst-on-target* (*BOT*). Both tanks must have the range indexed as announced by the team leader. One tank crew (No. 1) commences firing as designated by the team leader. The other tank crew (No. 2) also lays its gun with the correct initial sight picture and senses the round fired from tank No. 1. If the target is not destroyed, the gunner of tank No. 2 applies the primary method of sensing adjustment (burst-on-target) and fires a second round at the target. If properly applied, BOT should produce a second-round hit; however, if for some reason this is not obtained, the gunner of tank No. 2 can then fire the last two rounds of the non-sensing method of adjustment (par. 117) with the starting point for the corrections being the sight picture used for the round adjusted by BOT. The two-tank method of BOT can be applied even more rapidly than one tank applying BOT when firing sensing rounds. Furthermore, it is simple to perform because once the team leader has indicated that two-tank BOT will be used, no further commands are necessary until target destruction has been obtained or the drill has been completed.

(2) *Firing tank and observing tank.* One tank is designated by the team leader as the firing tank and the other the observing tank. (These designations can be reversed for subsequent target engagements.) When the firing tank fires, the tank commander of the observing tank senses the round using his binocular and, based on this sensing, announces a subsequent fire command to the gunner of the firing tank. This procedure is continued until the target is destroyed. The gunner of the observ-

ing tank lays his sight on the center of vulnerability of the target and senses each round fired, but remains silent unless his tank commander announces LOST. In this case, if the gunner of the observing tank has sensed the round, he will announce a subsequent fire command to the gunner of the firing tank. If he also failed to sense the round in this situation, he too would announce LOST and his tank commander would make corrections based on his judgment of the situation (par. 108*e*). This method is not as rapid as two-tank BOT, but does have the advantage of disclosing only one tank's position. For night employment of this method of adjustment, see paragraph 155*b*.

142. Destruction of Armored Vehicles

Armored vehicles are combat vehicles that provide armor protection for the crew. This class of vehicles includes tanks, armored self-propelled guns, armored personnel carriers, armored utility vehicles, and heavy armored cars. The destruction of armored vehicles involves many factors, foremost of which are ammunition capabilities, range, and target vulnerability.

a. Ammunition Capabilities. Types of armor-defeating ammunition are shot, hypershot, sabot, HEP, and HEAT. The first three listed are in the kinetic energy category and the last two in the chemical energy category. Usually light and medium armored vehicles are engaged with shot or HEP, and heavy armored vehicles are engaged with any of the other types; but this does not always hold true. For example, if only the front or the turret of a medium tank is exposed, it may be necessary to use a type of round usually reserved for heavy tanks. Some effect against armored vehicles can be obtained by HE and smoke, but these projectiles are not armor-defeating. HE has some concussion effect against crews and is capable of damaging vehicular suspension systems, tracks, and sighting devices. It is effective also against carriers and self-propelled guns with no overhead protection, and against crews dismounting from vehicles. Against armor, smoke is used for screening and incendiary effect.

b. Effect of Range. At close ranges (approximately 1,000 meters (yards) or less) the determination of range is not difficult, and the relatively flat trajectory of the projectile compensates considerably for range errors. As the range increases, however, range determination becomes less accurate and the trajectory of the projectile becomes more arched, thus decreasing the probability of a target hit. Adjustment also becomes more difficult at longer ranges, due to decreased visibility. Additionally, range has a direct effect on kinetic energy projectiles. As the range increases, the penetration capability of shot, hypershot, and sabot decreases proportionally. Range does not have this effect on chemical energy projectiles. They have a penetration capability independent of range. Due to the many factors involved, it is not possible to set a maximum effective range for engaging armored vehicles. If a target is not immediately dangerous, it should be engaged at the closest possible range consistent with obtaining surprise. On the other hand, armored vehicles are engaged at long ranges if they are engaging the tank or attempting to flee. Also, when fighting a delaying action or engaged in a fire support role, it may be necessary to engage enemy armor at extreme ranges (over 3,500 meters (yards)).

c. Tank Vulnerability. The vulnerability of an armored vehicle depends on the combination of actual armor thickness and slope of the armor plate, called equivalent thickness. The slope of the armor plate is determined by the construction of the vehicle and its position in relation to the tank that is taking it under fire (angle of engagement). Equivalent thickness becomes greater as the amount of slope increases and the angle of engagement decreases, because there is more armor placed in the path of the projectile (fig. 76). Thus, a tank of given armor thickness with flat surfaces perpendicular to the line of fire is more vulnerable than a tank of the same thickness with sloped surfaces oblique to the line of fire. Tanks have sloped surfaces whenever possible and have the heaviest armor on the front of the hull and turret. The sides and rear of the turret have less armor, and the least amount is on the sides and rear of the hull. The sides and rear of the hull also have flatter surfaces and are the most vulnerable parts of a tank. As no enemy willingly presents such a target, the center of vulnerability varies with the amount of target exposed and the angle at which it is engaged. Figure 77 shows the vulnerability of a medium tank. If it is possible to get a flank or rear shot at a tank, the center of vulnerability is the center of the hull. The center of vulnerability of a tank engaged head-on is the turret ring. Vulnerability decreases considerably when tanks are in hull defilade. Although it is possible to penetrate the sides of a tank turret with shot ammunition, penetration of the front of the turret is less likely. Enemy tanks in hull defilade, no matter what type, should be engaged with a type of armor-defeating ammunition usually reserved for heavy tanks.

d. Armor Thickness. When considering the selection of a type of ammunition or weapon to use in engaging a target, classification of

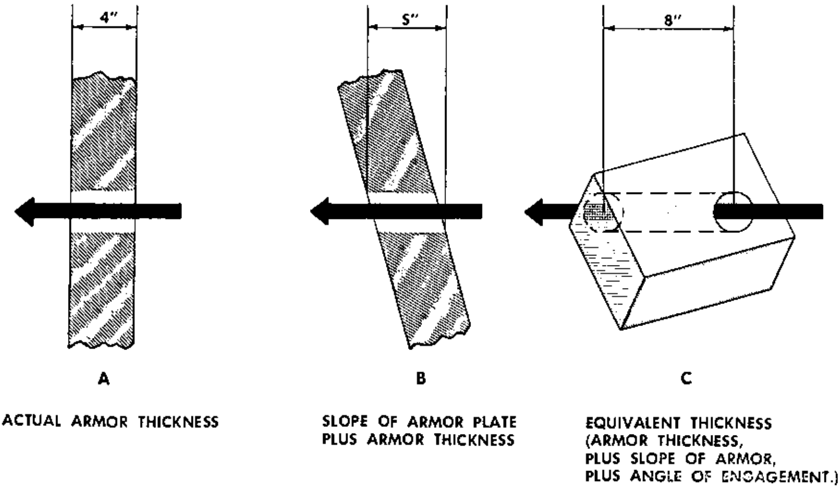


Figure 76. Equivalent thickness.

armor-protected vehicles into categories of light, medium, and heavy refers to the equivalent thickness of their armor protection (minus angle of engagement) and not to any weapon that might be mounted on the vehicle. Light tanks or other lightly armored vehicles are those that have an equivalent thickness of armor protection no greater than ½-inch on the major portion of the vehicle; medium tanks and other vehicles with medium armor protection, from ½ to 4 inches; heavy tanks and other vehicles with heavy armor protection, greater than 4 inches. Intelligence officers should classify enemy armor-protected vehicles into these categories and furnish the tank crews with this information, along with recognition characteristics. The decision of the commander on type of ammunition or weapon to use in engaging armor-protected vehicles is based on the classification of the vehicle (in terms of equivalent thickness of the armor protection), the angle of engagement, and the portion and amount of the vehicle exposed to direct fire. Classification of armor-protected vehicles should be revised when actual engagement of such targets reveals that the initial classification was in error.

143. Destruction of Unarmored and Lightly Armored Vehicles

Unarmored and lightly armored vehicles are vehicles that can be penetrated by small arms fire or by the fragmentation of high explosive ammunition. Unarmored vehicles include trucks and automobiles of all types; lightly armored vehicles include half-tracks, scout cars, and some types of armored cars and personnel carriers. Heavy armored cars that cannot be penetrated by small

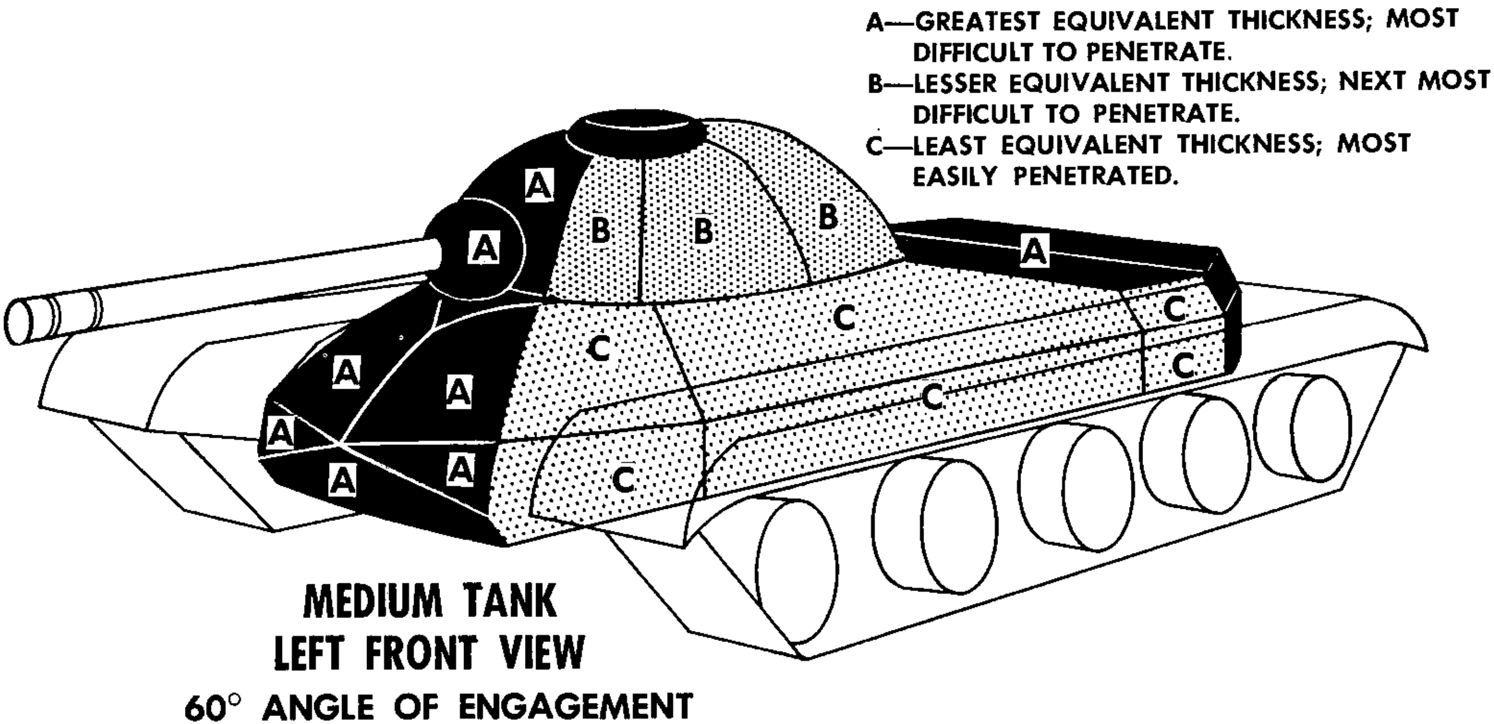


Figure 77. Tank vulnerability.

arms fire should be engaged with armor-defeating ammunition. If a doubt exists as to the classification of any armored vehicle, armor-defeating ammunition should be used to insure destruction. Unarmored vehicles are vulnerable to all types of fire, but their speed often makes them difficult to hit. The coaxial machinegun normally is used for engaging unarmored and lightly armored vehicles at ranges up to 900 meters. At greater ranges, caliber .50, HE, or HEP ammunition should be used. Moving targets at close ranges are easier to hit with machinegun fire, and main gun ammunition is conserved for more dangerous targets. The aiming point varies with the type of target. For example, vehicles are immobilized by hitting the engine, suspension system, or driving compartment.

144. Firing at Dismounted Troops

Dismounted troops constitute an area target of varying depth, width, dispersion, and vulnerability.

a. Attacking infantry should be engaged with machinegun fire whenever possible; however, the types of weapon and ammunition employed depend primarily on the range and the actions of the enemy troops. Normally, HE or HEP is employed against troops at ranges in excess of 1,600 meters. At lesser ranges, the fire of the machineguns is added to that of the main gun. When firing the machineguns at troops in the open, the gunner should traverse and search through his assigned sector. When possible, he should employ grazing enfilade fire. Depending on the configuration of the terrain, ricochet fire may be effective against troops advancing under cover. At very close ranges, canister is most effective against mass attacks, but consideration must be given to the location of friendly troops before this type of ammunition is fired.

b. Assaulting tanks employ the coaxial and caliber .50 machineguns while moving; firing into trenches and other vulnerable parts of the enemy defense. Smoke also can be employed for its incendiary, screening, and casualty-producing effect.

145. Destruction of Crew-Served Weapons

Crew-served weapons include antitank guns, towed artillery, recoilless rifles, machineguns, and mortars. Engagement of crew-served weapons in bunkers and pillboxes presents a problem different from that in engagement of ground mount crew-served weapons (par. 146). Crew-served weapons are sometimes encountered in hasty positions, but usually are placed in prepared positions with good cover and concealment. They present small targets with low silhouettes. Normally, HE or HEP is employed against these weapons, but enemy positions with little or no cover may be engaged with machineguns within effective range. Due to their dangerous nature and ability to achieve surprise, antitank guns may require engagement from battlesight. When crew-served weapons are engaged, the crew is the primary target, but destruction of the gun also should be accomplished. Often, both enemy gun and crew will be well dug-in; in such cases, it may be necessary to employ ricochet fire.

146. Engagement of Field Fortifications

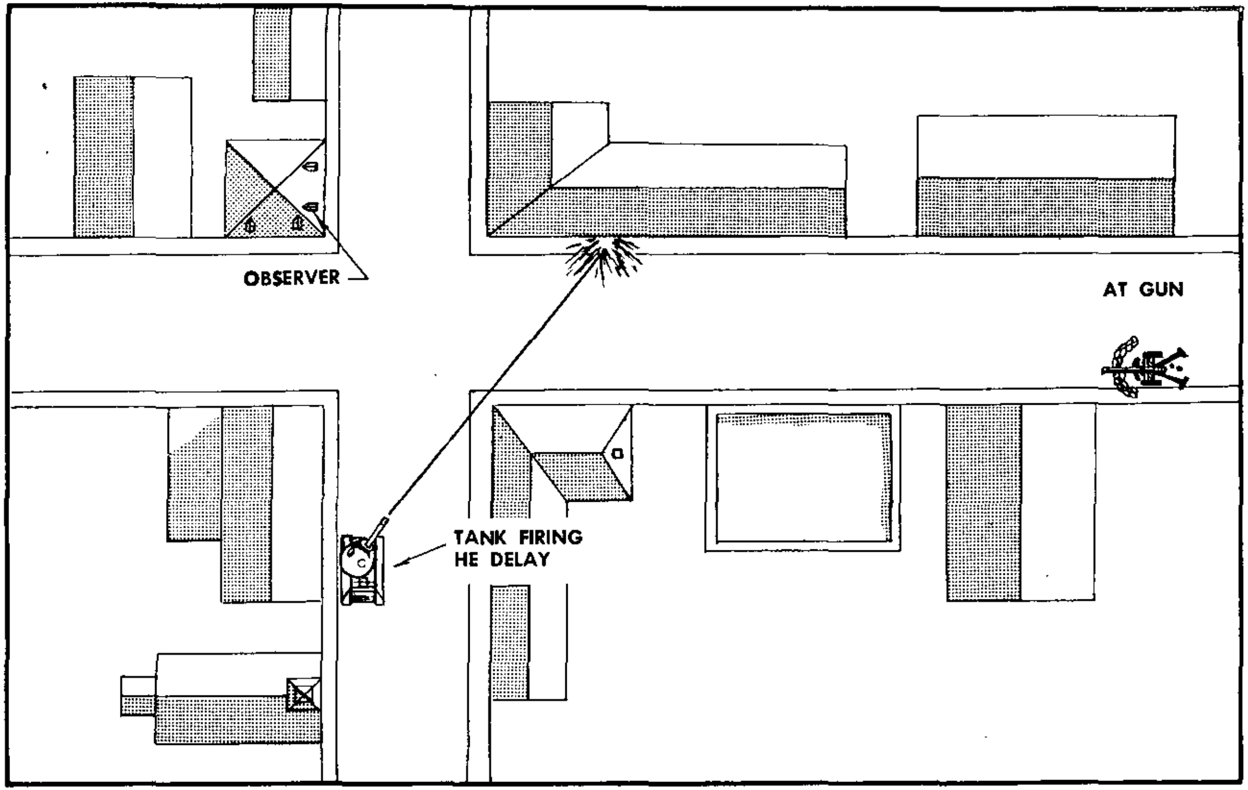
Field fortifications are defensive positions constructed to afford good fields of fire and protection to the troops and weapons within them. Such a position usually consists of a series of connecting, mutually supporting strong-points. In addition to entrenchments and weapons emplacements, field fortifications include positions with overhead cover such as bunkers, pillboxes, and built-up areas. Fire alone will not defeat a well-fortified position; it is necessary to assault it. The following techniques of engaging specific types of fortifications will provide the effective fire support vital to the successful attack of a fortified position:

a. Open Entrenchments. Foxholes and trenches provide protection against direct fire, but they are vulnerable to airbursts. Ricochet fire (par. 138) should be employed against such fortifications. If the ground does not produce good ricochet effect, impact fire will neutralize much of the enemy's firepower, because he must expose himself to employ his weapons. At close ranges, machineguns also may be used to neutralize enemy firepower.

b. Open Weapons Emplacements. Open gun positions have some vertical surfaces and are vulnerable to both impact and ricochet fire. Impact fire is more accurate, but a well-constructed emplacement may require ricochet fire. The range and the degree of protection afforded by the position will determine whether the main gun or the machineguns should be employed.

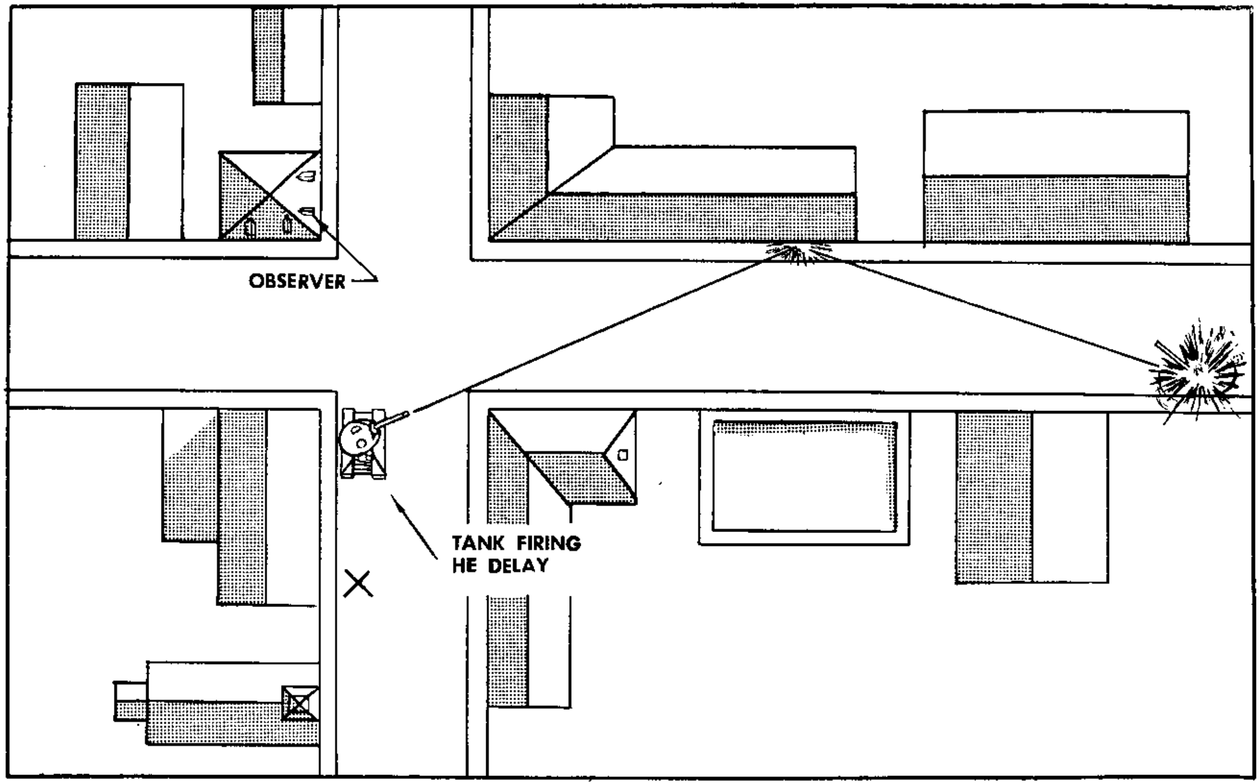
c. Bunkers and Pillboxes. Bunkers and pillboxes provide good protection against all types of fire, but they can be penetrated by attacking their structural weaknesses with the proper ammunition. The most vulnerable part of both bunkers and pillboxes is the aperture. A direct hit with HE or HEP at the aperture of a bunker will result in part of the force of the explosion and fragmentation being directed inside the bunker. The possibilities of achieving detonation inside a bunker are increased by employing HE delay as it may ricochet inside if it strikes near the aperture. If the angle of strike does not allow a ricochet, chances of penetration or damage to the structure are increased by the delayed detonation. The concrete-piercing fuze is more effective than the standard fuze against concrete or masonry and may be issued for this type of operation. Should HE concrete prove ineffective, armor-defeating ammunition may be used. Shot will penetrate most log bunkers, but more than one round may be necessary. Once penetration has been obtained, HE, HEP, or smoke can be fired through the opening with devastating effect. The technique of attacking pillboxes by fire is generally the same as for bunkers except that the additional strength of concrete prohibits use of HE delay for penetration purposes. The concrete-piercing fuze is designed to penetrate pillboxes or to weaken the structure so that subsequent rounds of HE concrete will penetrate and produce a blast effect inside. Armor-defeating ammunition will achieve deeper penetration than HE concrete, but will not cause as much destruction after penetration. The choice of ammunition for engagement of bunkers and pillboxes depends primarily on ammunition availability and target vulnerability. However, employment of HE or HEP has a greater casualty-producing effect and conserves armor-defeating ammunition for use against armored vehicles.

d. Built-Up Areas. Built-up areas provide strong defensive positions and are excellent fortifications even when badly damaged or reduced to rubble by bombardment and cannon fire. Buildings, particularly those constructed of concrete or masonry, constitute strongpoints that normally must be reduced by a combined arms attack. Buildings and other structures are engaged in much the same manner as bunkers and pillboxes. HE or HEP should be fired through windows, doorways, shell holes, and other openings. HE delay will penetrate wood and other light structures; HE concrete, HEAT, shot, hypershot, or sabot is required to penetrate concrete or masonry walls. In all cases, the desired effect is detonation inside the building; therefore, once penetration is effected, HE or HEP should be fired through the openings made. Smoke has a casualty-producing effect and is also effective against buildings, particularly those that will burn. Smoke fired into the ground floors produces rising fumes and smoke, which force the occupants out and may cause the building to burn. Reduction of built-up areas produces rubble which, due to its thickness and irregular surfaces, forms a nearly impenetrable position. Troops barricaded behind such a strongpoint are effectively engaged by ricochet fire. Ricochet fire can be used also to "shoot around a corner" by banking HE delay off a wall (figs. 78 and 79). In this case, deflection corrections are the main consideration in obtaining a target hit.



ADJUSTING HE DELAY "AROUND CORNER." ANGLE OF STRIKE TOO SHARP; NO RICOCHET.

Figure 78. Shooting around a corner—wrong.



ADJUSTING HE DELAY "AROUND CORNER." ANGLE OF STRIKE ALLOWS RICOCHET.

Figure 79. Shooting around a corner—right.

147. Special Uses of Tank Ammunition

In addition to the specific techniques of target destruction previously mentioned, there are a variety of special uses of main gun and machinegun ammunition that have proved effective in battle. Combat situations may arise where the following fire techniques could be effectively employed.

a. Use of HE and HEP. HE and HEP are versatile types of ammunition as they can be employed in numerous ways against a wide variety of targets. The following special uses are in addition to those previously discussed:

(1) They give excellent fragmentation effect when fired into treetops over the heads of enemy troops. With HE, superquick fuze normally is used; however, if the trees are exceptionally tall or the troops are deep in the woods, delay fuze should be used.

(2) They may be employed in the reduction of certain obstacles such as roadblocks and barbed wire. HE or HEP fire weakens the structure and explodes antipersonnel mines, but they normally will not detonate buried mines. After an obstacle has been reduced by fire, it should be checked for boobytraps and the immediate area should be probed for antitank mines. HE or HEP are not effective in clearing minefields. Clearance of extensive obstacles by fire is not practical because it requires too great an expenditure of ammunition.

(3) They may be used in reconnaissance by fire of probable enemy positions beyond the effective range of the caliber .50 machinegun.

b. Use of Smoke. As smoke is employed for screening, incendiary, and casualty-producing purposes, there are many combat situations where use of this round, particularly in conjunction with other ammunition, will produce excellent results.

(1) Screening blinds the enemy, allowing greater freedom of movement of friendly forces. Smoke may be placed in front of the enemy to screen the maneuver of attacking tanks or to cover their withdrawal. Tanks are capable of temporarily screening short movements of the tank platoon or company. Due to the limited supply of this type of ammunition and the tendency of WP smoke to dissipate and rise rapidly, tanks should be employed for screening purposes only when other sources are not available. The basic factors governing the employment of smoke are wind direction and velocity. With a wind

from the flank, the screen is started to the windward side of the target so that it will drift into and in front of the enemy. With a tailwind, smoke should be placed just in front of the target; with a headwind, smoke should be placed on or behind the target. When the wind velocity is high, the rate of fire must be increased to maintain the screen. When firing into a strong headwind, consideration must be given to smoke drifting over friendly positions.

(2) In addition to its incendiary effect on buildings and log fortifications, smoke is also effective in burning out enemy positions in woods and brush. The factors of wind direction and velocity that govern the employment of smoke for screening apply also to its use for burning purposes. HE, HEP, or machinegun fire should be employed in conjunction with smoke to destroy and harass enemy troops driven from cover by fires.

(3) The casualty-producing effect of smoke is a direct result of its incendiary nature. Best results are obtained when it is fired into an enclosure, such as a bunker or the room of a building. It is also effective against troops in the open, because the burning phosphorus sticks to the skin and clothing. Although smoke does not have the destructive capability of HE or HEP, it has a much greater psychological effect on troops.

(4) Smoke can be used also to mark targets.

c. Use of Machinegun Fire. Main gun ammunition is conserved by employing machineguns—

(1) For reconnaissance by fire on suspected enemy positions and suspicious areas.

(2) To designate targets.

(3) To set fire to dry brush, grass, or wood (incendiary and tracer ammunition).

(4) In conjunction with HE or HEP when engaging troops in the woods. Due to dispersion, machinegun fire will penetrate deeper into the woods with only partial deflection by trees and brush. The caliber .50 machinegun is particularly effective for this purpose.

Section X. RANGE CARDS

148. General

A range card is a diagram or sketch of an area, showing the tank positions, existing and probable targets, and in some cases, prominent terrain features, all in relation to their actual position on the ground. Range cards are used as an aid in placing accurate fire on plotted targets and targets of opportunity during periods of good and poor visibility. (Good visibility is during the day or at night when the battlefield is illuminated and targets can be seen; poor visibility is at night or during periods of bad weather in daylight, such as fog and heavy snow, when the targets cannot be seen. Firing during poor visibility is indirect fire, as the azimuth indicator and quadrant must be used as an aid in laying the gun.) Range cards are used also as an aid in coordinating and concentrating the defensive fires of a unit. They are actually fire plans for individual tanks and are the basis for the fire plans of higher units. Range cards must contain, in addition to the reference point, the following information for each target plotted:

a. Target identification (designation and description).

b. Deflection (azimuth indicator reading—designated as either right or left of the reference point).

c. Quadrant elevation (QE—either plus or minus).

d. Range (from tank to target).

Note. Deflection and range are also recorded on circular range cards (par. 150) even though the target plot coincides with either of these graduations on the card.

149. When Range Cards Are Prepared

Range cards are prepared for all defensive positions (primary, supplementary, and alternate, in order of priority of preparation) and all static positions when contact with the enemy is possible, e.g., after occupying an intermediate objective when the time for continuing the attack is not definitely known. Time is an important factor because it influences the accuracy and completeness of information on a range card. The longer a unit is in position the more detailed range cards should be and the more accurate the information for each target. Range cards must be made during the time targets can be seen; therefore, the preparation of these cards must be given especially high priority when positions are occupied just before darkness.

150. Types of Range Cards

A range card must be complete and be constructed so that it can be easily read by all tank crewmen. The two types of range cards used in tank gunnery are the circular and the sketch range cards.

a. Cirular Range Card. The circular range card (fig. 80) consists of five concentric circles with the center of the card representing the tank's position, each circle representing a range, and the outer circle representing, in addition, a deflection scale. The deflection scale is a reproduction of the azimuth or inner scale on the azimuth indicator, with graduations every 100 mils and numbered every 200 mils (the numbers in parentheses on the right side of the card are disregarded, as they have no application in tank gunnery). Targets are plotted by deflection and range, with the zero deflection line representing the direction to the reference point. Target data are recorded on the range card by drawing lines from the center that correspond to the range and deflection to each target. Each line is positioned by interpolation; therefore, it is necessary to record the deflection even though it may coincide with a graduation on the deflection scale. The circles may be designated any range to conform with the terrain, but even though the range to a target is the same as one of these circles, range is recorded. The value of this type of range card is the simplicity of preparation and ease of reading; however, a circular card may not be suitable if a tank has a narrow sector of fire with many probable targets. The limited amount of space available for plotting targets and recording data is often insufficient in such a situation. In this case, the targets can be plotted on the card and data recorded elsewhere on the card or a sketch type card used.

b. Sketch Range Card. The sketch range card (fig. 81) is a simple drawing of the sector of fire of a particular tank. The drawing is schematic with only key terrain features, the reference point, and the tank positions designated. Known and probable targets are circled and identified. Target data are recorded on a line extending from the tank position to each target. Because it need not be drawn exactly to scale, this type range card provides ample space for plotting targets. It may be used for more than one firing position if there are not too many targets to be plotted. If one card is used for two or more firing positions, the plotting of targets and recording of data can be accomplished with a different colored pencil for each position to increase the ease of reading. The value of the sketch range card depends on the ability of tank crewmen to draw a simple, legible diagram. Each range card is marked in the upper right-hand corner with a P, an A, or an S, or a combination of these letters, to indicate primary, alternate, or supplementary firing positions. If a combination of letters is used, each firing position is marked also with a P, an A, or an S. On tanks that have a range card as on-equipment materiel, one method of plotting all positions on one card would be to draw

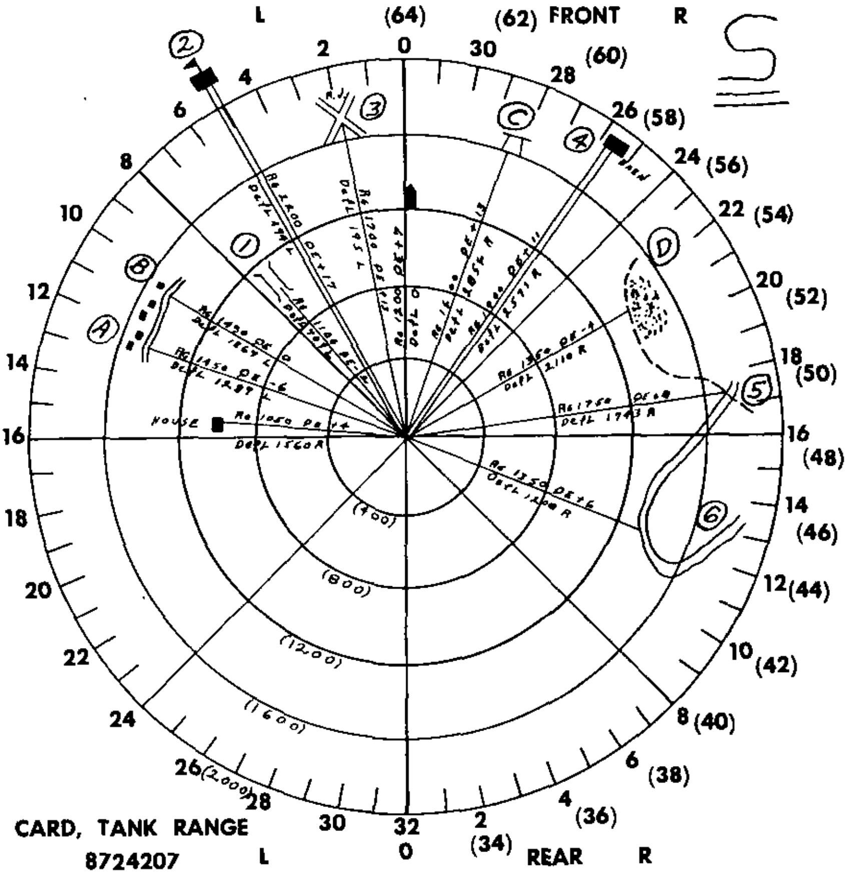


Figure 80. Circular range card.

a sketch range card on the blank side, for the primary and alternate positions, and use the reverse side (circular range card) to plot the supplementary position.

151. Obtaining Range Card Data

a. Tank in Position. When the tank is in firing position, the necessary data for a range card are obtained by use of the fire control equipment on the tank. Specific techniques for obtaining the data will vary for different type tanks, but the general method is the same.

(1) Targets are designated and numbered by the company or troop commander, i.e., 1, 2, 3, etc. Additional targets may be selected by the platoon leader, and designated by letters, e.g., A, B, C, etc., or by tank commanders. Those selected by tank commanders are neither numbered or

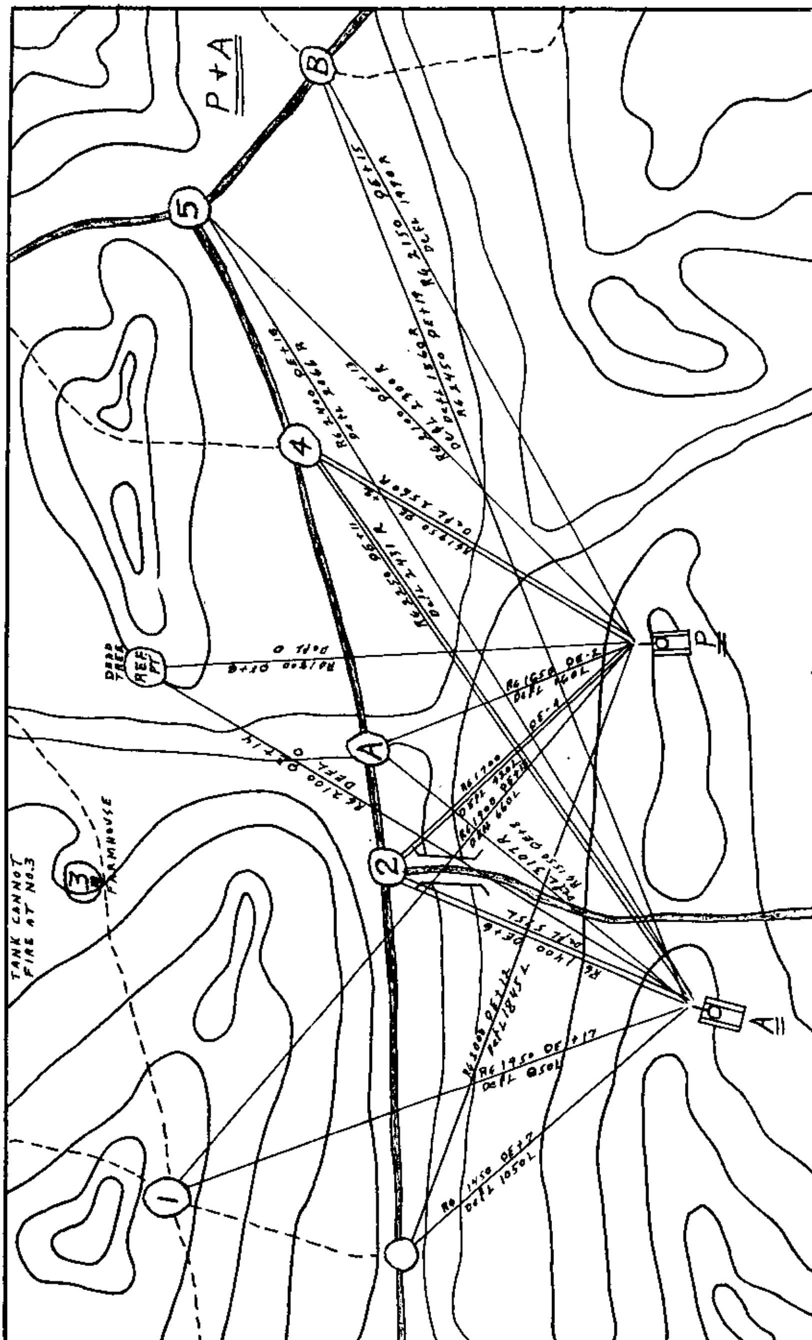


Figure 81. Sketch range card.

lettered. All targets must be plotted on the range card of each tank even though they cannot be engaged by a particular tank. No line is drawn or data recorded to a target that cannot be engaged. For increased clarity, targets are identified by a brief word description or symbol or by both of these. The reference point for each range card is selected by the tank commander. It must be easily identified, fairly permanent, e.g., the edge of a building, and readily seen from the tank position. It is described in the same manner as a target (with the abbreviations *Ref Pt* to indicate the reference point on sketch range cards), and all other information is recorded for this point to enable the crew to fire at a target that might appear at or near the reference point.

(2) Deflection is obtained by laying the aiming cross in the primary direct-fire sight on the reference point, zeroing the azimuth indicator, traversing to each target, and recording the azimuth indicator reading, including direction from the reference point, i.e., right or left.

Note. Aiming stakes with shaded lights that cannot be seen by the enemy are placed in line with the reference point for use at night when necessary.

(3) Range is obtained by use of the range finder or by the most accurate means available. If estimation is used initially, a more accurate range should be determined at the earliest opportunity.

(4) Quadrant elevation is obtained by indexing the range and HE or HEP ammunition into the fire control system, laying on the center of the target with the direct-fire sight, centering the bubble in the elevation quadrant, and reading the quadrant elevation on the quadrant scales. HE or HEP ammunition usually is used under conditions of poor visibility to obtain the benefit of the bursting radius, but if more than one type of HE is available, or if the use of another type of ammunition is anticipated, separate quadrant elevations must be obtained and recorded. These data may be placed elsewhere on the range card along with any other additional information that would increase the value of the range card.

b. Tank Not in Position. The tactical situation often makes it necessary for tanks to occupy firing positions at night (fig. 82). Such an operation requires detailed planning and coordination to be accomplished efficiently. If a tank unit relieves another tank unit, the unit being relieved marks all tank firing positions (indicating to liaison personnel from the relieveing unit which are the primary, the alternate, and the supplementary positions), places aiming stakes out for a reference point for each primary position if it is a night occupation (with the relieving unit furnishing the necessary lighting devices), and gives the relieving unit the range cards for each of the positions. At night, if no unit is being relieved, or if the unit being relieved is other than a tank unit, range cards are prepared for at least one firing position per tank by daylight reconnaissance parties before moving tanks into position. The minimum equipment required by this reconnaissance party to prepare these firing positions and range cards is 1 aiming circle, 2 aiming stakes per firing position, a shielded light for each aiming stake, a map, a firing table, and engineer tape to mark the positions. The reconnaissance party should consist of an officer or noncommissioned officer in charge, an aiming circle operator, and at least one representative per platoon. Upon arrival in the area, the reconnaissance party selects the tank firing positions. To prepare a range card for a position, the aiming circle is set up in the center of the position and two aiming stakes are set up as a reference point for that position. The aiming stakes are set up in line at any angle from the firing position except within 100 mils of the direct front or direct rear, because placement of the reference point in such a position will not facilitate accurate positioning of the tank. A shielded light is attached near the top of each aiming stake. One stake is placed approximately 15 to 25 meters from the firing position and the other at twice this distance. The light on the far stake should be at a higher elevation than the light on the near stake. When the gunner sights on the reference point, the tank will be properly positioned when the far light appears to be above and in line with the near light; he then zeros the azimuth indicator. Firing data are obtained as follows:

(1) Targets are designated in the same manner as when the tank is in position. The unit commander, when briefing the reconnaissance party, will assign sectors of responsibility for each platoon and, from his map study, select the targets that appear to be the most important. Additional targets are selected at the new position by the reconnaissance party.

(2) Deflection is obtained by zeroing the aiming circle scales, laying the telescope of the aiming circle on the reference point, measuring the angle from the reference point to the target, and subtracting the aiming circle reading from 3,200. (An aiming circle reading to be used in

conjunction with an azimuth indicator must always be less than 3,200; therefore, if the reading on the upper scale exceeds 3,200, the reading on the lower scale must be used before subtracting.)

(3) Range is determined by using the most accurate means available. As no tanks are available, range must be determined by a means other than registration or use of the range finder.

(4) Quadrant elevation (QE) is obtained by combining superelevation (elevation for range) with angle of site. Superelevation (always plus) is determined by use of a firing table (HE or HEP ammunition). Angle of site (plus or minus) is measured with the aiming circle.

Examples.

1.	Superelevation for 1,700 meters:	9.3
	Angle of site:	4.3
	Quadrant elevation:	13.6 or 14
2.	Superelevation for 1,300 meters:	6.7
	Angle of site:	—8.0
	Quadrant elevation:	—1.3 or—1

Note. A plus angle of site is added to superelevation and a minus is subtracted. Both superelevation and angle of site are determined to the nearest tenth of a mil and when combined to form a quadrant elevation, the result is rounded off to the nearest whole mil; .4 of a mil and less, to the next lower whole mil; .5 of a mil and more, to the next higher whole mil.

For preparation and occupation of night firing positions, see paragraph 154.

152. Tactical Use of Range Cards

In addition to providing a means of enabling the tank crew to fire at targets that cannot be seen (using the quadrant elevation and deflection to lay the gun (par. 62)), range cards assist the crew in firing at targets that can be seen by providing a predetermined range to each target. They are an aid also in organizing static and defensive positions and in coordinating the defensive fires of a unit. The company commander assigns sectors of responsibility to each platoon and designates targets within these sectors that are to be included in the platoon fire plans. The platoon leader in turn assigns a sector of primary responsibility to each tank (marked off on the range card by double lines leading to two targets that are inclusive for responsibility) and designates targets by number (those assigned by the company commander) or letter, that are to be included on the range cards of each tank in the platoon. The sectors of responsibility must be overlapping to insure complete coverage, and all targets designated by the platoon leader must be plotted on all range cards (including those of the platoon leader's tank) even though they cannot be taken under fire by a particular tank. Each tank in the platoon uses the same number or letter for each target designated by the platoon leader. Fire can then be coordinated by calling for fire on targets by number or by letter. Tank commanders may select additional targets to plot on range cards, but they are not numbered or lettered. Before submitting a platoon fire plan to the company commander, the platoon leader checks all range cards to insure that the platoon sector of responsibility is adequately covered by fire. If any target is not adequately covered by fire, the platoon leader must either reposition tanks or, for targets that cannot be engaged by tank fire, request fire support to cover these targets. Tanks fire at targets of opportunity within their assigned sectors unless or until ordered to assist in repelling the enemy by fire in other sectors. Improvement of range cards is a continuing process; errors in data are corrected as more accurate data are obtained as a result of firing at targets, and additional target locations, or possible locations, are plotted to fill in gaps that may exist on the range cards.

Section XI. FIRING DURING POOR VISIBILITY OR AT NIGHT WITH ILLUMINATION

153. General

Tank crews must be capable of delivering effective fire on the enemy at night or during conditions of poor visibility such as dense fog, heavy snow, smoke, or heavy rain. Effective fire during periods of poor visibility requires advance planning and coordination. When neither visibility nor illumination exists, it is necessary to fire with the aid of previously prepared range card data. However, when the target is visible, direct fire is employed.

154. Preparation and Occupation of Night Firing Positions (Tanks Not in Position)

After the range card for a tank's firing position is completed (par. 151*b*), the position of the aiming circle is marked by a stake to indicate the tank turret center. Two strips of engineer tape, intersecting at the stake, are laid out for use in guiding the tank into position. The longer strip marks the tank route, the shorter strip marks the tank position (fig. 82). The two aiming stakes used as a reference point in preparing the range card are left in position as the reference point for the tank. The shielded light on each aiming stake is turned on after insuring that the enemy cannot detect the lights from his position. The tank firing position is now ready for occupation. After dark, the tank is moved into position by a dismounted guide using a shielded flashlight to signal the tank driver. Light discipline must be observed. The only interior lights of the tank that are turned on are those that are necessary to the operation, e.g., lights for the azimuth indicator and quadrant. A piece of white tape or a chalk mark on the front center of the tank hull is used alining the tank with the route-marking tape. The gun is traversed to the approximate angle of the reference point and the tank is moved slowly forward until it is centered over the position stake. The gunner controls the final positioning of the tank by giving directions to the driver and moving the gun as necessary to superimpose the sight reticle onto the reference point. The gunner then zeroes the azimuth indicator and traverses the gun to the target area. The tank is now properly positioned for night firing.

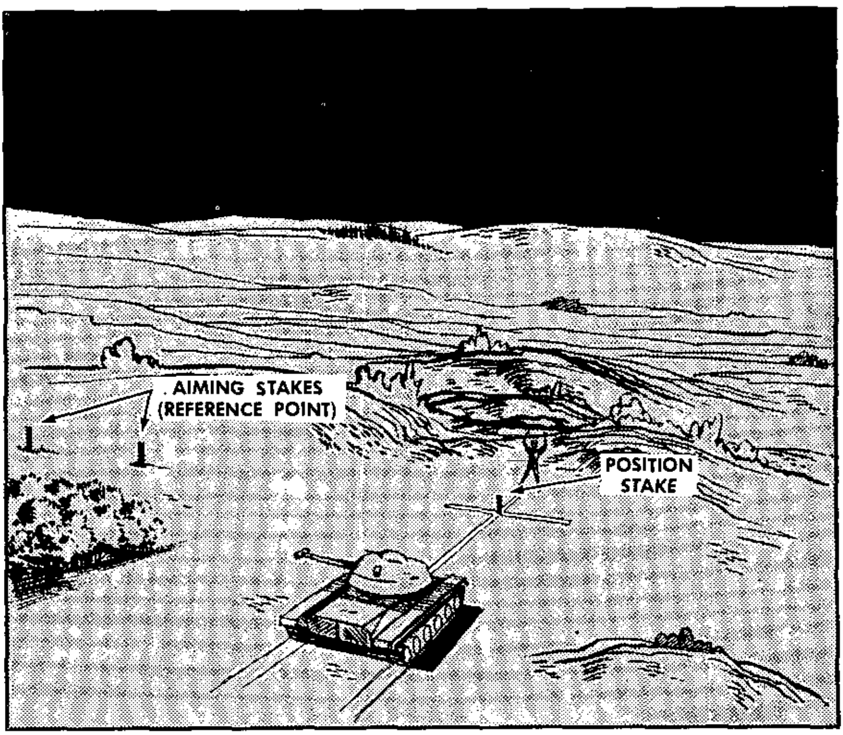


Figure 82. Night firing position.

155. Firing During Poor Visibility

During firing at night with no illumination or during daylight periods of poor visibility, HE or HEP ammunition is employed to obtain the benefit of the blast and fragmentation effect on the target when a direct hit is not obtained. Firing at night discloses the tank position and often requires a considerable expenditure of ammunition to obtain effective results. The decision to fire is based on the importance of the target, the ammunition supply, and the knowledge that firing positions will be disclosed.

a. Engagement of Plotted Targets. To fire on a plotted target, range card data is applied to the auxiliary fire control instruments. The gunner indexes the quadrant elevation on the quadrant scales, traverses to the prescribed azimuth indicator reading, zeroes the gunner's aid, and elevates or depresses the gun, using the *manual* controls, until the leveling bubble is centered. The sequence of performing these steps is important because if the tank is canted, the gun may not be properly laid unless the leveling bubble in the quadrant is centered as the last step. Also, the leveling bubble must be recentered each time the weapon is fired. This is accomplished after the weapon is loaded to insure that the gun is correctly laid. Once the azimuth indicator has been zeroed on the reference point, laying the gun on any target is accomplished without referring back to the reference point. When the gun is laid for deflection, the gunner's aid on the azimuth indicator is zeroed for use in making subsequent deflection changes for firing at a particular target. Even when it is impossible to adjust fire by observation, target hits may be observed under certain conditions. For example, HE or HEP striking metal causes a bright flash and has an incendiary effect on some targets. When target effect is not visible, area fire (fig. 83) may be employed to increase the probability of damaging or destroying the target. Area fire is the firing of a prescribed number of rounds of HE or HEP in a prescribed pattern. The standard area fire pattern consists of five rounds. The initial round is fired from range card data; subsequent rounds are fired 1 mil over, 1 mil short, 10 mils right, and 10 mils left of the first round. This pattern gives an area coverage of approximately 200 meters (yards) in depth at all ranges and of a varying amount of width depending on range to the target. Other area fire patterns may be devised to increase the effectiveness of this type of fire for areas with particularly unusual terrain configurations. If additional patterns are used, they must be lettered for uniformity and rapid use. To indicate that area fire is to be used, the words *area fire* replace the ammunition element in the initial fire command. Announcing only the words AREA FIRE means that the standard pattern will be employed; announcing AREA FIRE followed by a letter, e.g., AREA FIRE ALPHA, means a pattern devised by the unit is to be employed. Upon receiving an *area fire* command, the gunner fires the first round using range card data, and the remaining rounds in the prescribed pattern without further commands.

b. Engagement of Targets of Opportunity. It is sometimes possible to lay the tank gun for direction by sighting on a gun flash, especially if the flash occurs within the gunner's sector of observation. Range estimation is difficult, but a fairly accurate range can be determined by counting the number of seconds between the flash and the sound, and multiplying this number by 400 (the approximate distance in yards sound travels per second). The range obtained as a result of these computations can be used as meters or yards without further figuring because of the approximation involved. Fire is adjusted by using area fire or by employing the gunner of an adjacent tank as observer (par. 141). When two tanks are employed, they form a team, with one tank designated the firing tank and one the observing tank. To prevent distorted sensings, the tanks should not be more than 50 meters apart. Each gunner lays the aiming cross in his direct-fire sight onto the center of the flash and the gunner of the firing tank indexes range, centers the bubble in his quadrant (using the micrometer knob), and zeroes the gunner's aid on his azimuth indi-

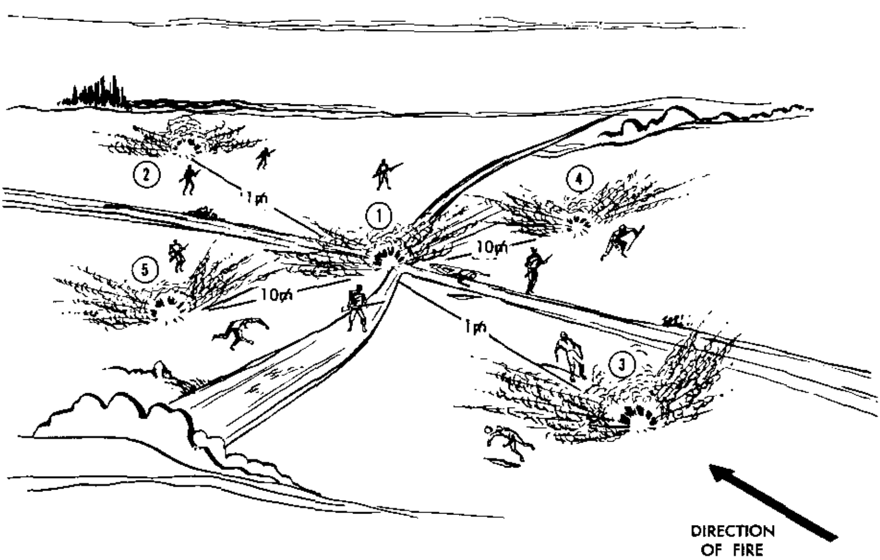


Figure 83. Standard area fire pattern.

cator. (On a tank with fire control equipment that causes the sight to move when range is indexed, it may require two flashes of the enemy weapon to lay the gun accurately.) The gunner and tank commander of the observing tank sense each round fired and the gunner gives a subsequent fire command to the firing tank. In the event the gunner fails to sense the round, he announces LOST and the tank commander issues the subsequent fire command. The standard range change does not apply. The gunner of the firing tank makes range and deflection changes by use of the quadrant and azimuth indicator. Firing continues until target effect is observed or fire has been adjusted to where it is sensed as appearing at the center of the observer's aiming cross. If fire has been adjusted without visible results, area fire may be employed.

Note. This same general method may be employed to engage enemy searchlights.

156. Fire Commands for Firing During Poor Visibility

When the target is not visable and the tank gun must be laid with the aid of the auxiliary fire control equipment, range is announced as a quadrant elevation and direction announced as a deflection (azimuth indicator reading).

Examples.

Alert	GUNNER	GUNNER
Ammunition	TWO ROUNDS HE	AREA FIRE
Range	QUADRANT PLUS ONE THREE	QUADRANT MINUS SIX
Direction	DEFLECTION TWO FIVE FOUR SEVEN RIGHT	DEFLECTION FOUR THREE TWO LEFT
Description	ANTITANK	TROOPS
Execution	FIRE	FIRE

Note. Announcing AREA FIRE in place of the ammunition element means that HE or HEP ammunition will be employed unless stated otherwise. Even though the target cannot be seen, the description element is announced for morale purposes and to aid the gunner in determining target effect, when possible.

157. Firing With Illumination

a. When a target is engaged that can be seen, no matter what the source of illumination, direct-fire methods are employed as they are more rapid and accurate than indirect-fire methods. At night, artificial light (and sometimes moonlight) provides sufficient visibility to allow target engagement by direct fire. The gunner lays the gun on the target using his direct-fire sight and fires, using the appropriate method for adjusting subsequent rounds. Fire commands are the same as for engaging any stationary or moving target during daylight. Artificial illumination is provided by searchlights (tank-mounted visible or infrared light and artillery 60-inch searchlight), illumination shells (mortar and artillery), flares (trip flares, rifle flares, hand-held flares, and those released from airplanes), or fires in the target area. Fires may be started in the target area by firing smoke or machinegun incendiary or tracer ammunition at such flammable objects as brush, trees, or wooden buildings. Before any target or target area is illuminated, consideration must be given to the effects of this illumination on friendly troops. All adjacent friendly units must be notified when and where artificial illumination will be used so they can take action to insure that their positions and activities are not exposed.

b. Techniques of Night Firing. Certain techniques, if properly followed, will greatly increase the effectiveness of direct-fire at night.

(1) *Blackout turret.* All unnecessary lights and all lights that do not have intensity control must be turned off. If any cannot be independently turned off, they should be covered so no light shows or the bulb removed. Intensity-controlled lights necessary for firing must be properly adjusted (dimmed as much as possible consistent with continued use). Shaded flashlights are used for reading scales, etc., on instruments without intensity-controlled light.

(2) *Night vision.* To acquire night vision, tank crewmen should not be subject to light for approximately 30 minutes before firing at night. Once night vision is obtained, it must not be destroyed by exposure to intense light. During firing, both the tank commander and gunner must close their eyes momentarily (from the announcement of ON THE WAY until the tank gun has fired) to avoid the blinding effect of muzzle flash. The head must not be moved away from the sight because repositioning of the head may cause an incorrect sight picture and failure to sense. At night, the tank commander uses his direct-fire sight rather than his binocular to sense rounds, as it remains on the target, thereby preventing loss of orientation and, being inside the tank, it assists in avoiding loss of night vision from gun flash. Discretion must be exercised in this respect

so the tank commander does not become oblivious to surrounding events; he must periodically check areas other than the target area, using the binocular, which is more effective for observation and location of targets. At night, the gunner may decide to use the secondary rather than the primary sight if it is more efficient.

(3) *Reticle illumination.* The reticle of a direct-fire sight usually must be illuminated during night firing because artificial illumination is not always intense enough to provide contrast for viewing the etched reticle. When a reticle is illuminated for use, it must be kept as dim as possible to avoid glare.

(4) *Indirect initial lay of the tank gun for direct firing.* When the decision is made to illuminate a target or target area, the commander requesting the illumination must inform the firing tanks of the area to be illuminated so their guns can be laid before the target or area is illuminated. This technique increases the speed in which the target is taken under fire and, when using flares or illuminating shells, it increases the time available for firing at the target. When the tank commander of a firing tank is informed of the area to be illuminated, he refers to his range cards and determines which quadrant elevation and deflection to use to lay the gun on the target. If no data are plotted for this area, an estimated reading must be made based on plotted data and map information. When indirect-fire only is employed, there is no need to be concerned with the position of the sights, as the auxiliary fire control equipment is used to make subsequent changes in range and deflection. When going from indirect methods for initially laying the gun to direct methods for firing, however, there is a need to lay the sight on the target to use it for making adjustments. To lay the sight on the target, two additional items must be indexed in the fire control system that are not necessary for indirect firing: ammunition and range (the same items used to determine quadrant elevation). To inform the gunner that he will fire direct-fire after indirect laying of the gun is accomplished, the tank commander announces GUNNER, DIRECT FIRE as the alert element in his initial fire command. If the tank commander cannot index the range, he announces it just before the quadrant elevation, e.g., 1,400, QUADRANT PLUS 13. The gunner indexes ammunition (and range,

if necessary) and lays the gun at the announced elevation and deflection. To aline the sight properly, ammunition and range must be indexed before the gun is laid with the auxiliary fire control equipment. When a fire control system is used that does *not* introduce superelevation directly to the gun, and a type of ammunition is to be fired other than that used in computing range card data, the ammunition setting is changed after the target is illuminated and the gunner has identified the target (the gun must also be re-laid as indexing of another type ammunition will move the sight off the target). When a fire control system is used that *does* introduce superelevation directly to the gun, a new type of ammunition can be indexed immediately after range and the type ammunition used to compute range card data are indexed and the gun is laid with the auxiliary fire control equipment (even before the target is illuminated). With either type of system, the gunner is informed of the procedure to be followed by announcing, for example, INDEX (HE); FIRE (SHOT). The command FIRE is given after the target is illuminated.

Examples.	*Tank with rangefinder*	*Tank without rangefinder*
Alert	GUNNER, DIRECT FIRE	GUNNER, DIRECT FIRE
Ammo	HE	INDEX HE; FIRE SHOT
Range	QUADRANT PLUS ONE ONE	ONE TWO HUNDRED, QUADRANT MINUS TWO
Direction	DEFLECTION SIX NINE SEVEN LEFT	DEFLECTION TWO SIX THREE THREE RIGHT
Description	TROOPS	TANK
Execution	AT MY COMMAND—FIRE	AT MY COMMAND—FIRE

(5) *Illuminating shells* (*mortar and artillery*). Illuminating shells should be fired in groups of at least three to insure adequate illumination for tank firing. Time between rounds should vary from 10 to 30 seconds depending on wind conditions. The higher the wind velocity, the shorter the time interval between firing of each round. All rounds in an illuminating group should be fired so that the burst of each occurs at the same point. If a large area target (over 200 meters in width) is to be

engaged, additional illuminating groups should be fired as required. The burst of each illuminating round should occur at a height sufficient to insure burnout at approximately 10 meters above the ground. This prevents glare in the gunner's sight, which prevents him from making proper adjustments. When illuminating shells are fired, the tank commander assists the gunner in firing by informing him when maximum illumination will occur and advising him of complete burnout approximately 20 seconds before this condition occurs. By observing from his hatch periodically, the tank commander has a complete view of the illuminating group, while the gunner does not. Illuminating shells are best used to illuminate area targets. Careful consideration of the wind conditions must be made before this type of illumination is used, to avoid giving the enemy assistance in the location of your position and activities. For range and illuminating capabilities of each type of illuminating shell, see FM 20–60.

(6) *Searchlights (tank-mounted visible or infrared light and artillery 60-inch)*. When searchlights are used to bring a target in view, the procedure in (4) above, is used to lay the tank gun on the target before use of the searchlight.

(*a*) *60-inch searchlights.* The use of 60-inch searchlights requires coordination with the supporting searchlight unit. With this type of light, either direct (fused beam pointed directly at the target), indirect (reflecting the light off low-hanging clouds), or diffused (spreading of the light beam) light may be employed. Direct light results in better illumination of the target, but the other methods illuminate a larger area and make location of the searchlight by the enemy more difficult. The use of the various methods of lighting depends on weather conditions, types of target to be engaged, retaliatory ability of the enemy, and location of the searchlights. For range and illuminating capabilities of the 60-inch searchlight, see FM 20–60.

(*b*) *Tank-mounted searchlights (visible or infrared light).* Tank-mounted searchlights are best used against moving targets, point targets, and small area targets (50 meters or less in width). Tank-mounted searchlights must be properly focused (complete fusion of the light beam to obtain maximum efficiency of the light) and boresighted (parallel alinement of the center of the light beam with the axis of the gun tube (par. 52) to control the position of the light) before use.

Note. Tank-mounted searchlights are focused by maintenance personnel and not by the crew.

As only direct lighting can be employed for tank gunnery purposes, the tank-mounted searchlight can be quite vulnerable to enemy fire if not properly employed. The platoon leader coordinates the firing tanks and the searchlight tanks by fire commands. The alert element indicates the tanks to fire and the tanks to illuminate. The flicker technique is employed to reduce the enemy's opportunity to fire accurately on the searchlight. One light is turned on for 15 seconds and then turned off as another searchlight is turned on for 15 seconds (if only one searchlight is used, the flicker time is 15 seconds on and 5 seconds off). To further reduce vulnerability of the searchlight when the enemy has the capability of effectively firing on your position, no more than two 15-second periods of illumination should be performed by any searchlight tank before moving to a new position. When the enemy does not have the capability of effectively firing on your position, e.g., when being pinned down by fire, the position of the searchlight need be changed only as desired. When the platoon leader announces AT MY COMMAND, each tank commander with a mission must report READY. When more than one searchlight tank is to be employed, they will illuminate in the order given in the alert element, e.g., TISSUE ONE AND TWO, WHITE LIGHT MISSION (Tank 1 will illuminate first).

Example.

Alert	JELLY ROLL TWO AND FOUR, FIRE MISSION: THREE AND FIVE, RED LIGHT MISSION
Ammo	HE
Description	TARGET NUMBER THREE, TROOPS
Execution	AT MY COMMAND—FIRE

Note. After each tank commander reports ready, the platoon leader orders FIRE, which indicates that the previously designated tank illuminates and firing tanks fire when the target can be seen. As a searchlight is turned on by one tank, the searchlight on the other tank is turned off without command. Illumination and fire continue until the platoon leader orders CEASE FIRE.

(c) *Initial searchlight lay.* A searchlight is laid on a target by indirect means, prior to lighting, in the same manner as a tank gun. Once the light is turned on it may require a slight movement to bring the most intense part of the light on the center of the target or target area. Quadrant elevation, containing superelevation, is used to lay the searchlight for elevation. As a beam of light is straight, no additional elevation above angle of site is required; therefore, the quadrant elevation places the light slightly above the target. If time permits, crews on searchlight tanks can determine the angle of site to each target and use this figure by itself as the quadrant elevation when laying the searchlight by indirect means. The tank commander operates the ON-OFF switch for the searchlight. As the tank searchlight is mounted coaxially with the main gun, it is manipulated by the gunner using the gun controls. The tank commander has the searchlight laid initially by issuing an initial light command and makes adjustments as necessary by subsequent light commands.

Examples.

Initial light command

Alert	GUNNER
Searchlight	WHITE LIGHT
Range	QUADRANT PLUS ONE SEVEN
Direction	DEFLECTION ONE ONE THREE LEFT
Description	TROOPS

Note. When the gunner has completed laying the searchlight, he announces READY. The tank commander then turns on the searchlight when ready or as ordered.

Subsequent light command

1. ADD (DROP) ________ STEADY ____________ ON
2. RIGHT (LEFT) ______ STEADY ____________ ON

Note. Subsequent light commands can be issued by the gunner of the firing tank directly to the gunner of the illuminating tank, if the initial and subsequent lays are not satisfactory. Lights are turned off on the command, CEASE FIRE. For offensive operations, the light is turned on in the appropriate direction and adjusted on targets as required.

(d) *Illuminating versus firing.* Tanks mounting searchlights do not fire while illuminating for other tanks as obscuration from the firing reduces illumination of the target. For maximum effectiveness, illuminating tanks should be positioned a minimum of 50 meters laterally from firing tanks. When a tank crew must illuminate for its own firing, it is advisible to use a dismounted observer (par. 141), when possible, for adjusting fire because of the difficulty of sensing from the tank.

(7) *Obscuration.* Special consideration must be given to obscuration when firing at night with illumination. Because artificial light is less intense than sunlight, obscuration has an even more adverse effect on firing at night than it has during daylight firing. Nothing can be done to reduce obscuration at the target, but obscuration at the tank's position can be reduced by selecting a firing position that has a cover of vegetation. If this is not possible, the area around the firing position (especially the ground just below the muzzle of the gun) should be soaked with calcium chloride, water, or oil.

(8) *Training in performing crew duties at night.* Tank crewmen must be taught to perform their firing duties with little or no light. The crewmen must know their equipment and its location in the fighting compartment so well that they can identify and operate it without the benefit of light, e.g., the loader must be able to identify all types of ammunition and load them. This training can be integrated with other types of night training.

158. Firing Machineguns at Night

Machineguns are effective for firing during poor visibility or at night with artificial illumination except that the caliber .50 machinegun cannot be laid by indirect methods on targets that cannot be seen. The coaxial machinegun can be laid by indirect methods but quadrant elevation must be determined separately. The method of adjusting fire and destroying the target is the same as for firing during periods of good visibility. Tank machineguns are not laid on a final protective line as are ground-mounted machineguns; they are used for firing at targets of opportunity, the same as the main gun.

Section XII. MASSED FIRE

159. General

The concentrated, massed fire of the tank platoon or company produces a far greater destructive effect than do the uncoordinated fires of an equal number of tanks. Maximum firepower is obtained by coordinating and controlling the fire of all weapons of the tank unit and its attached and supporting units. Coordination of fire is accomplished at all levels of tactical command by use of a fire plan; actual control of fire is at the platoon or company level. The company commander coordinates fire by assigning sectors of responsibility to each platoon and by planning necessary supporting fires. He controls fire by issuing informal fire orders to one or more platoons to engage a target. Platoon leaders coordinate fire in the same manner as does the company commander, but they control fire by fire commands. Authority to fire on targets of opportunity within their sectors normally is delegated to platoon leaders and adjustment of fire is usually accomplished by the individual tank commanders or gunners.

160. Massed Offensive Fires

Massed offensive fires are planned and coordinated initially, but once the attack is rolling, tanks also engage targets of opportunity. Tanks of the maneuvering element usually fire individually at targets as they appear; however, the platoon leader may concentrate the fire of the platoon or section on an especially dangerous target.

161. Massed Defensive Fires

In a defensive situation, the fires of all available weapons are coordinated to obtain maximum effectiveness. Sectors of responsibility are assigned and fire plans are developed for these sectors. The tank company fire plan is used to coordinate the fires of the platoons. The platoon fire plan is used to coordinate the fires of each tank within the platoon. When the command or signal is given, tanks fire at targets of opportunity within their sectors (marked on their range cards by double lines). If an enemy attack is concentrated in one particular area, the fire of the unit can be shifted to this area by the company commander or platoon leader.

162. Platoon Fire Commands

The platoon leader controls distribution and volume of fire by issuing initial and subsequent fire commands (figs. 84 and 85).

Examples.

Point target	*Area target*
(PLATOON) FIRE MISSION	(PLATOON) FIRE MISSION
HE CONCRETE	HE
ONE SIX HUNDRED	TWO ONE HUNDRED
WATCH MY BURST	DIRECT FRONT

BUNKER	NUMBER TWO—RIGHT FRONT
AT MY COMMAND—FIRE	NUMBER THREE—RIGHT FLANK
	NUMBER FOUR—LEFT FRONT
	NUMBER FIVE—LEFT FLANK
	TROOPS
	AT MY COMMAND—FIRE
Ambush	*Night firing*
(PLATOON) FIRE MISSION	(FIRST SECTION) FIRE MISSION
SHOT	ONE ROUND HE
ONE THREE HUNDRED	TARGET NUMBER SIX
RIGHT FRONT	TROOPS
NUMBER FIVE—LEAD TANK	FIRE
NUMBER FOUR—SECOND TANK	
NUMBER TWO—FOURTH TANK	
NUMBER THREE—LAST TANK	
AT MY COMMAND—FIRE	

Note. Call words are used in place of unit designations or tank numbers. For control purposes, the number of main gun rounds of ammunition to be fired may be specified or a subsequent fire command to cease fire may be issued. Range as announced by the platoon leader indicates the range from his position and not necessarily from any other tank position. The range and direction elements in a platoon command assist the other tank commanders in locating the target and will always be included unless the targets are indicated by range card number. Portions of an area target are assigned to various tanks in the *direction* element. When multiple targets are encountered, they are assigned by the *description* element. When the platoon leader decides to control the time of firing, he commands AT MY COMMAND. This maintains the element of surprise and prevents the enemy from taking evasive action. Upon hearing this command, tank commanders signal or report READY when they are prepared to fire. All tanks fire on the platoon leader's command FIRE.

163. Actions of Individual Tanks in Massed Fire

Upon receiving a platoon fire command, each tank commander issues to his crew an initial fire command based on the platoon command. Unless otherwise specified, the platoon command also serves as the fire command for the platoon leader's crew. Adjustment is conducted by each tank crew; however, when neces-

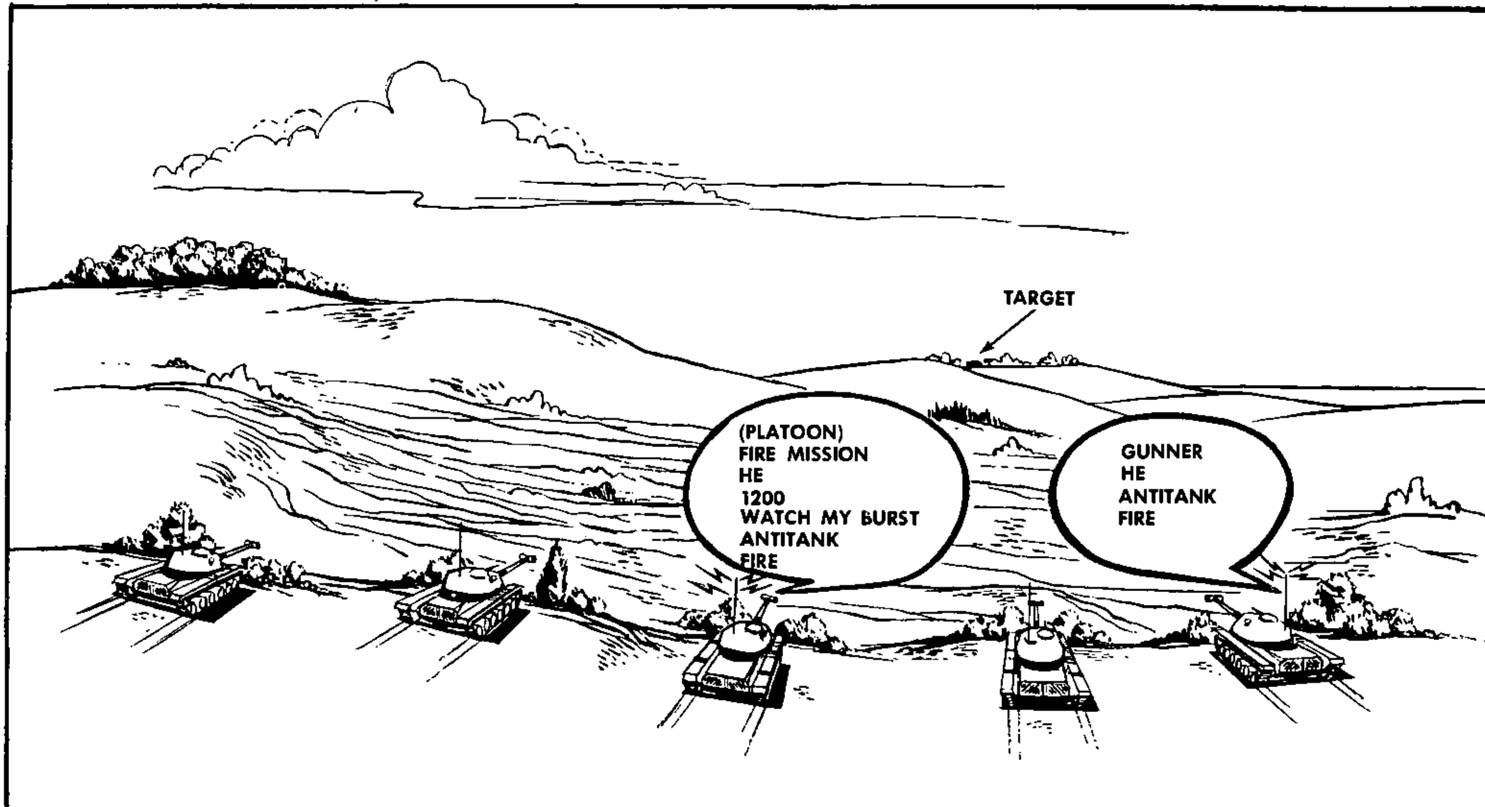


Figure 84. Engagement of a point target by a tank platoon.

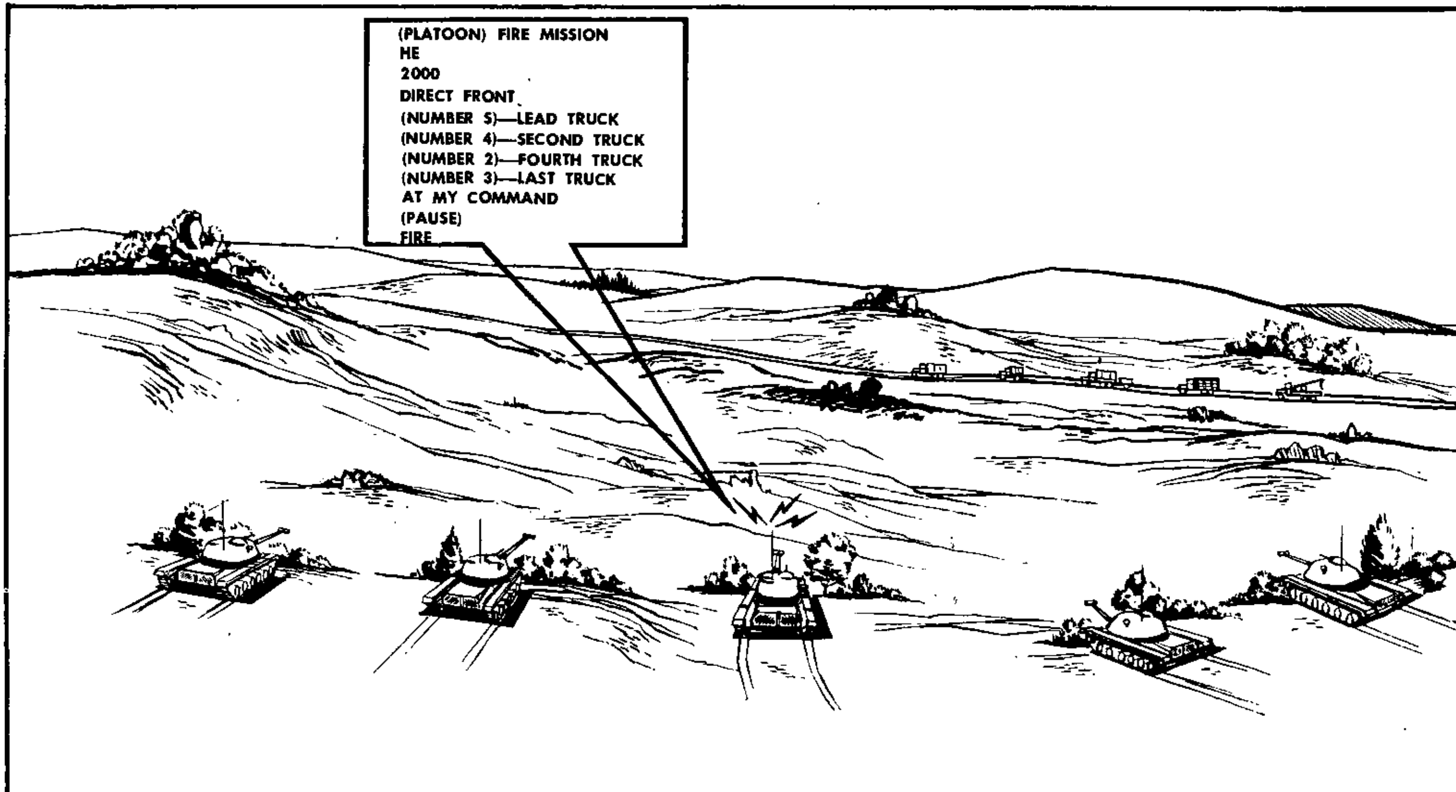


Figure 85. Ambush by a tank platoon.

sary, the platoon leader controls the fire of the platoon by specifying the number of rounds to be fired or by issuing a subsequent fire command to cease fire. When firing during poor visibility, the platoon leader's control of the volume of fire may be exerted by specifying AREA FIRE instead of the number of rounds to be fired. Area fire or the number of rounds to be fired is also announced, when appropriate, by a tank commander so that the gunner and loader know when to stop firing and loading.

Note. If a range card is used by a platoon leader to coordinate fire during periods of poor visibility, he must give the card to his gunner, after extracting the necessary information, so that the gunner can apply the appropriate data to the auxiliary fire control equipment. This is necessary also if the same procedure is used during good visibility and the gunner must index range in the fire control system. When a platoon leader does not want his crew to fire, he announces DO NOT FIRE just before issuing a fire command to other tank crews. When a gunner hears the description element of a command, when the target cannot be seen and after laying the gun with the auxiliary fire control equipment, he announces READY.

Section XIII. INFANTRY DESIGNATIONS OF TARGETS FOR TANK FIRE

164. General

Fire coordination between tank and infantry units normally takes place at company and platoon level; however, situations may arise where this coordination can be best accomplished between tank commanders and infantry squad leaders or individual infantrymen. Infantry assist tank units by locating targets. Tank units assist infantry by engaging targets dangerous to dismounted troops and those that cannot be destroyed by infantry weapons. To notify tank commanders of target locations or to request tank fire on particular targets, the infantryman contacts a tank commander by external interphone or radio. The action taken by the tank commander upon receipt of the information or request by the infantryman depends on the situation and the delegation of firing control within the tank unit.

165. Method of Requesting Fire and Designating Targets

The following elements are required from an individual requesting fire or designating targets:

a. Identification of the individual.

b. Warning—fire mission or target.

c. Direction—a general direction or reference point.

d. Range—by estimation unless stated otherwise.

e. Description of target—briefest term consistent with clarity.

Examples.

	Request for fire	*Target information*
Identification	THIS IS THE SQUAD LEADER OF THE SECOND SQUAD, THIRD PLATOON.	THIS IS PFC SHAVERS, FIRST SQUAD, SECOND PLATOON.
Warning	FIRE MISSION	TARGET
Direction	LEFT FRONT	DIRECT FRONT
Range	SIX HUNDRED	ONE FIVE HUNDRED
Description	MACHINEGUN	ANTITANK

Note. The amount of detail required in the identification element depends on the length of time the infantry and tank units have been operating together; call words are used with the radio. Announcing FIRE MISSION indicates a request for fire and announcing TARGET indicates information on a target location. All tank commanders receiving a request for fire or information on target location will acknowledge the call and maintain contact with the infantryman until the target is located. When a request for fire is received, the tank commander notifies the requester as to whether or not the target will be taken under fire.

CHAPTER 8
INDIRECT FIRE

Section I. INTRODUCTION

166. General

Under exceptional circumstances, tank crews may be required to employ indirect fire. This chapter discusses conduct of indirect fire of tanks, including determination of minimum elevation, firing data, registration, fire requests and commands, and adjustment of fire. This discussion is primarily concerned with indirect fire of the tank unit operating independently; however, paragraphs 196 through 200 contain implementing instructions for tank units operating in conjunction with artillery units. The tank platoon is the basic fire unit in an indirect fire role.

167. Types of Indirect Fire

Indirect fire is fire delievered on targets that cannot be seen through the direct-fire sights. Normally HE, HEP, or smoke ammunition is employed for indirect firing. The types of indirect fire employed by tank units are—

a. Range Card Firing. Tanks employ indirect fire from direct-fire positions when firing at night without artificial illumination or during periods of poor visibility. Range cards are used in this type of fire (pars. 148–152).

b. Tanks in Defilade. Tanks employ indirect fire from complete defilade positions, usually against area targets. Tanks are laid and fired as a unit; fire is adjusted by an observer. Fire direction and control may be organic or conducted in conjunction with artillery units.

168. Firing Positions for Indirect Fire

a. When selecting a position for indirect fire, the commander of the tank unit considers the immediate mission, future mobile missions, and the security of his command. The following are characteristics of a good indirect fire position:

(1) Located so fire can be placed on targets in the assigned sector. The position must be well forward, but not so near a hill mask that close-in targets cannot be engaged (fig. 86).

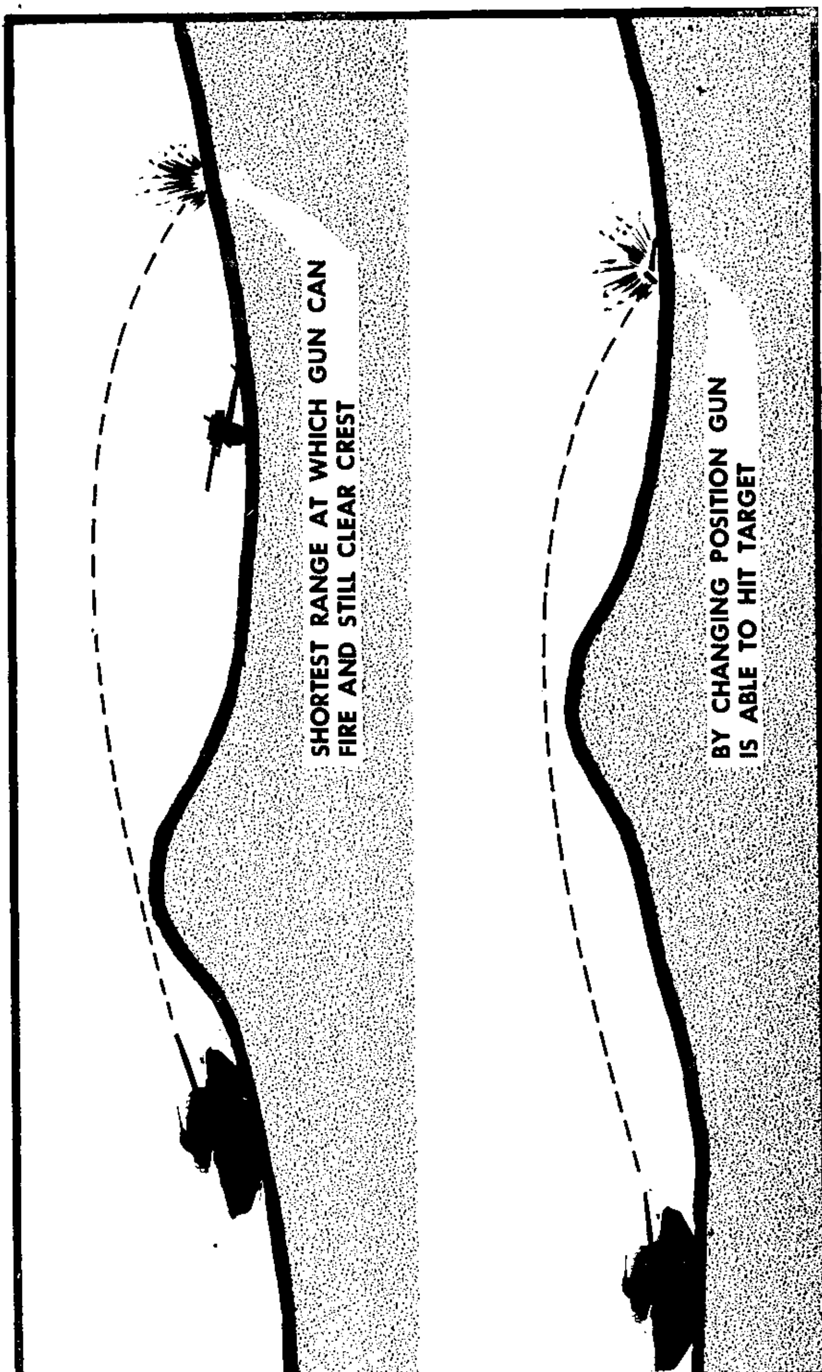


Figure 86. Positioning tanks for indirect fire.

(2) Located so the tank unit can revert rapidly to its primary role of offensive combat. Multiple access routes, concealed if possible, are required to allow tanks to be moved without delay and to permit supply.

(3) Provide hardstanding with level ground.

(4) Located behind a mask, so that tanks have full cover.

(5) Permit 6,400-mil traverse, so that tank crews can fire in any direction.

(6) Allow proper dispersion of tanks.

b. When firing indirectly, tanks are numbered from right to left. To occupy a firing position rapidly and smoothly, the platoon leader's tank (No. 1) moves in on the right with each succeeding tank taking position to the left. Tanks are positioned 35 meters apart laterally, but not in a straight line; staggering the tanks provides fire coverage in depth, permits firing to the flanks, and provides passive defense against enemy fire (fig. 87).

c. The unit's basic load of ammunition should not be used for indirect fire; when such employment is contemplated, ammunition is stockpiled beforehand. The commander must always be ready to commit his tanks in a mobile role if the situation permits.

169. Implementing Instructions for Laying Tank Guns Parallel

Once tanks have been positioned, all gun tubes are laid parallel in the direction of fire by use of an aiming circle or by reciprocal laying (par. 67). To accomplish reciprocal laying, the fire control officer inspects his map and selects a prominent (reference) point that is in line with the firing position and target area and visible from the firing position. The tank guns are then laid parallel, using the reference point selected. He may, instead of using a reference point, determine the grid azimuth from the firing position to the approximate center of the assigned sector and lay the tank guns parallel on this azimuth. Regardless of the method used, when all guns are parallel in the general direction of fire, the fire control officer draws a line on the map connecting the firing position and the approximate center of his sector of fire. This line is a temporary reference point line of zero deflection until the platoon can be registered on a registration point. All gun tubes are parallel to this reference point line, which permits ease of control (facilitates shifting of fires by one fire command). When tank guns are laid parallel and fired with the same quadrant elevation and deflection placed on all guns, the rounds burst in the target area in direct relation to the location of the tanks in the firing position. The fragmentation effect of an HE or HEP

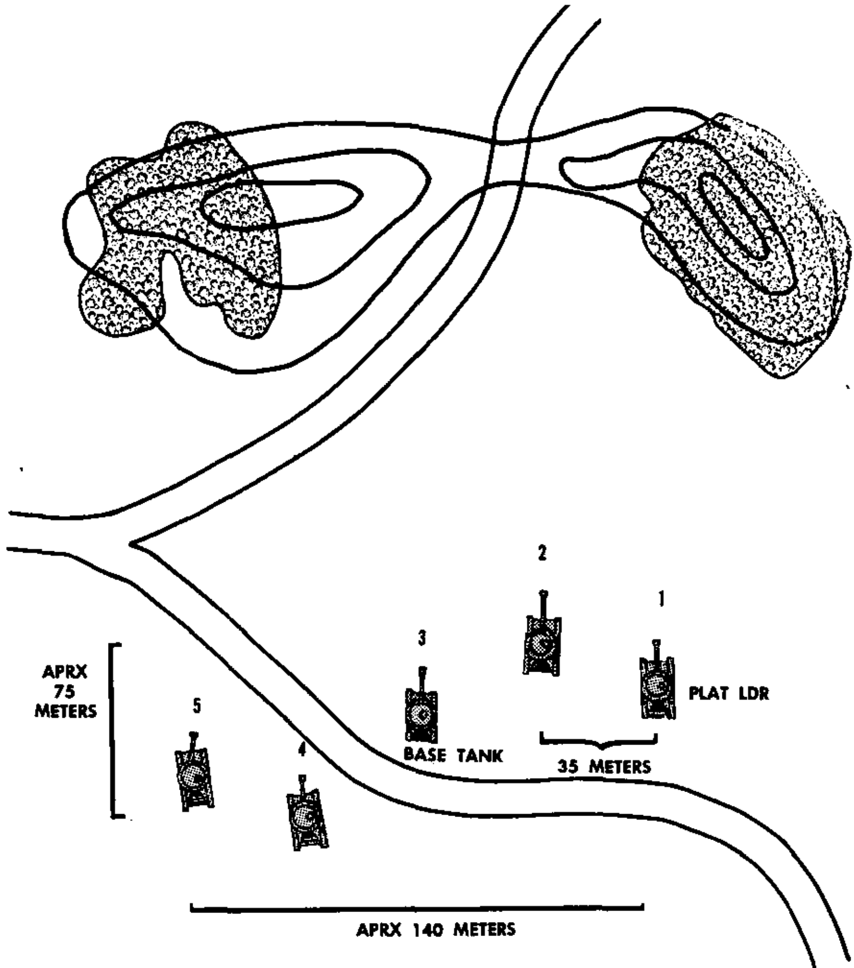


Figure 87. Platoon firing position.

burst is nearly all to the sides, with little effect to the front and rear (fig. 88). This characteristic gives good area coverage in width, and staggering of the tanks in position produces coverage in depth. Area coverage is obtained because the effective bursting area of all tank gun HE or HEP ammunition is *approximately* 35 to 45 meters in width and 5 to 8 meters in depth, and the tanks are positioned 35 meters apart and staggered 50 to 100 meters in depth (fig. 89). The fire control officer can shift this fire to a new target by issuing a single command, because all tanks are firing with the same quadrant elevation and deflection.

170. Minimum Elevation

a. General. Upon occupation of the position, the crew of each

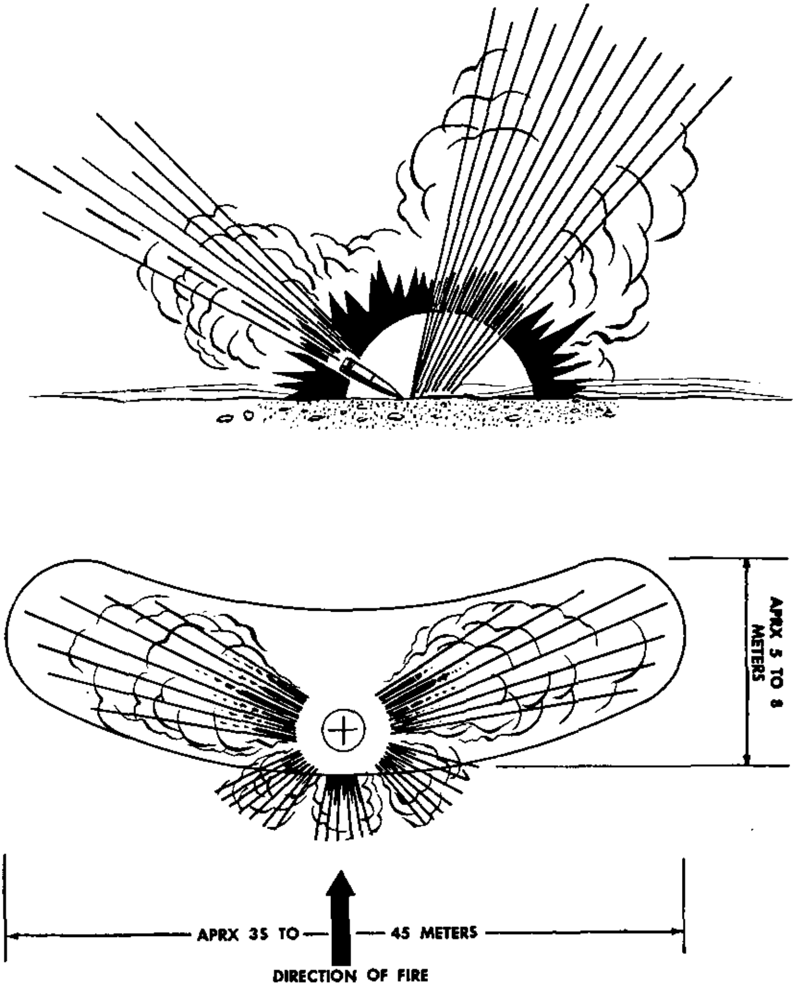


Figure 88. Approximate fragmentation pattern of HE or HEP burst.

tank will determine minimum elevation. Minimum elevation is the lowest elevation at which the gun can be fired with assurance that all projectiles will clear the mask to the front, including allowance for the safety of friendly troops occupying the mask, when appropriate. Tanks are not permitted to fire below minimum elevation.

b. Determining Minimum Elevation.

(1) The crew determines minimum elevation by combining the following factors:

(*a*) *Angle of site* (to mask). The vertical mil angle between the horizontal and the line of the bore when

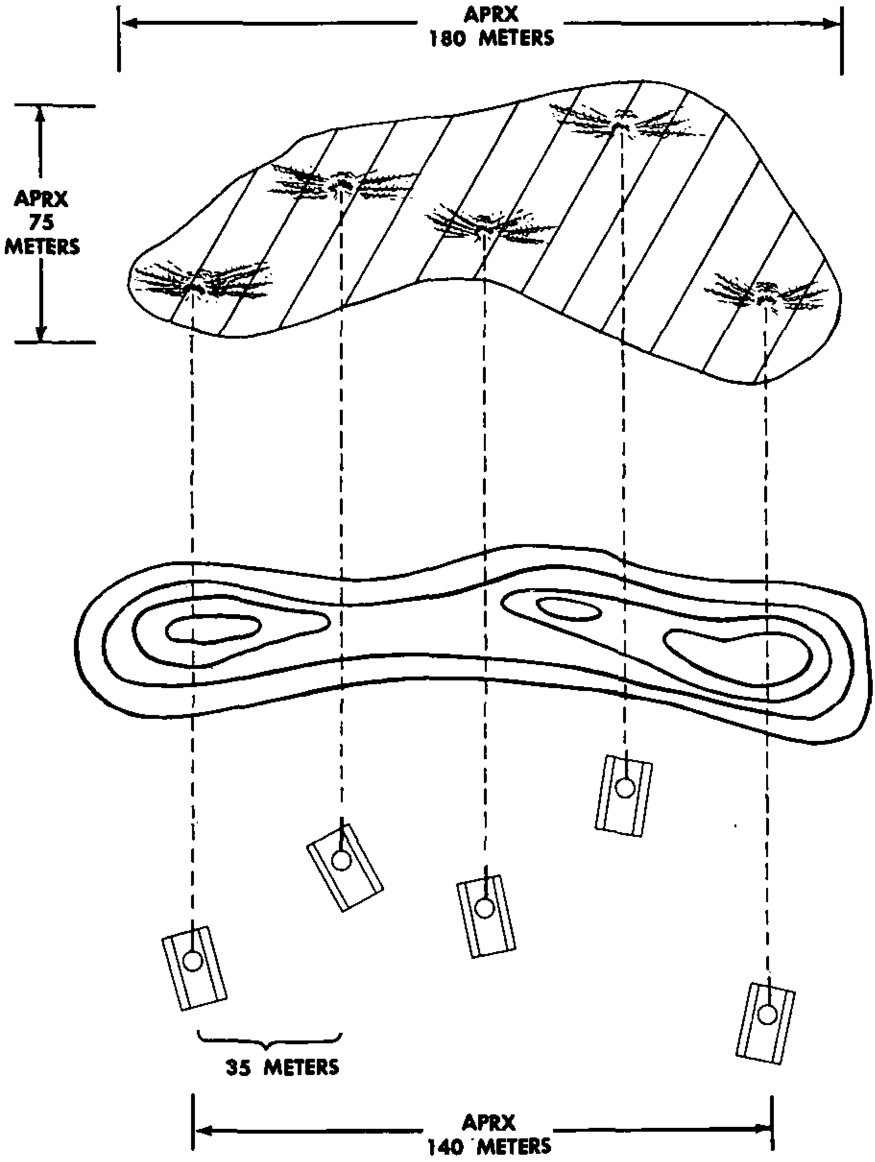


Figure 89. Obtaining area coverage with a tank platoon.

the gun is laid on the top of the mask is determined as follows:

1. With the breech open, the loader sights along the bottom of the tube as the gunner elevates the gun until the loader's line of sight just clears the highest part of the mask (A, fig. 90). The loader continues to sight along the bottom of the tube while the gunner traverses the gun between the limits of the firing sector to insure that the highest part of the mask was selected; if not, the process is repeated.

2. The gunner then measures the existing elevation of the gun, using a gunner's quadrant, and records this mil reading as the angle of site.

Note. Do not round off fractions or decimals.

(*b*) *Elevation for range* (to mask). Determine elevation for range from the firing position to the top of the mask, for HE or HEP ammunition, as follows:

1. Determine the range to the mask by the most accurate means available (ch. 5).

2. Obtain the mil elevation for that range from a ballistic computer or tabular firing table and record this mil angle as elevation for range. This is added to angle of site (B, fig. 90).

Note. Do not round off fractions or decimals.

(*c*) *Clearance factor.* To insure mask clearance of all rounds fired (C, fig. 90) add 2 mils to the sum of the angles in (*a*) and (*b*) above.

(*d*) *Troop safety factor.* If the mask is occupied, or is to be occupied, by friendly troops, the vertical angle that subtends a vertical distance of 5 meters (yards) at the range to the mask is added to the sum of (*a*), (*b*), and (*c*) above (D, fig. 90). Using the mil relation, solve for m to determine the mil angle (par. 38).

(2) The sum of the factors above (3 or 4—depending on whether the mask is occupied), expressed in mils, is minimum elevation (E, fig. 90). If the sum is fractional, the next *higher* whole mil is used. Figure 91 is an example of how to determine minimum elevation.

c. Platoon Minimum Elevation. Each tank commander reports his minimum elevation to the platoon leader as soon as it is determined. The highest minimum elevation reported is established as the minimum elevation for the platoon. Each gunner records this figure for future reference. At any time during firing that the gunner receives a quadrant elevation below platoon minimum elevation, he will cease fire and announce BELOW MINIMUM ELEVATION.

171. Quadrant Elevation (Angle of Site and Elevation for Range) and Deflection

a. General. For indirect firing, the gun is elevated a certain number of mils (quadrant elevation) for each target, based on

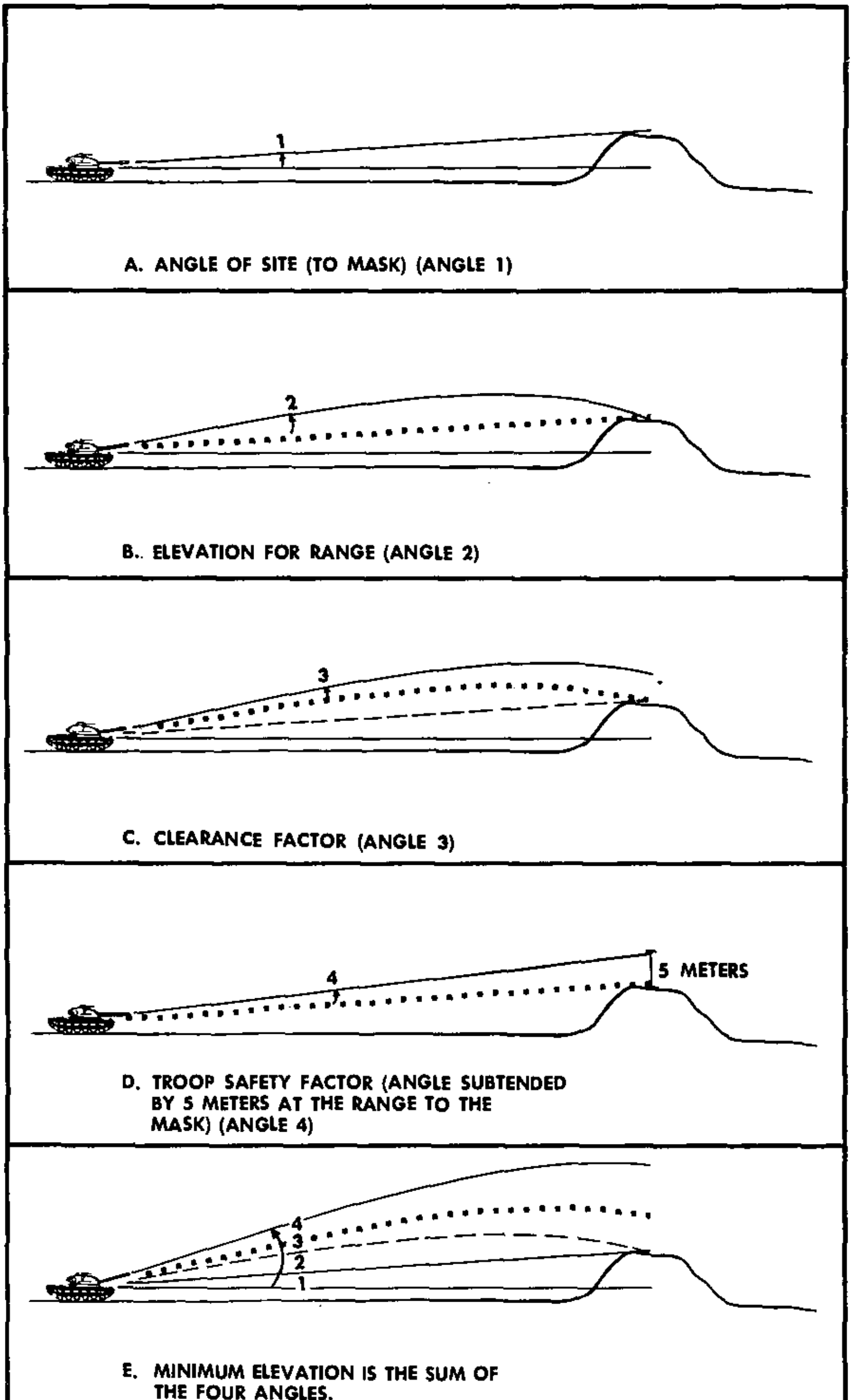
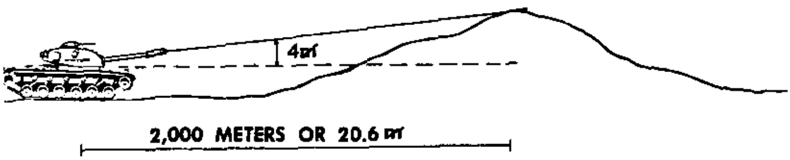


Figure 90. Determining minimum elevation.



1. ANGLE OF SITE (TO MASK) .... 4 MILS
2. ELEVATION FOR RANGE 20.6
3. CLEARANCE FACTOR 2
4. TROOP SAFETY FACTOR 2.5

29.1 OR MINIMUM ELEVATION = 30 MILS

$₥ = \frac{W}{R} = \frac{5}{2} = 2.5$

Figure 91. Minimum elevation problem.

range (elevation) and angle of site, and is laid in a certain direction (deflection) in relation to a known line of reference.

b. Quadrant Elevation. Quadrant elevation is the algebraic sum of elevation for range and angle of site (par. 175). For indirect fire from complete defilade, quadrant elevation is usually plus, but for rare situations it could be a minus reading.

(1) *Angle of site.*

(*a*) *Effect of angle of site.* With the gun laid at a correct elevation for a certain range, the projectile will hit a target at that range only when the target is at the same *altitude* as the gun. If the target is on higher ground than the gun, the projectile will strike short; if the target is lower than the gun, the projectile will strike beyond (fig. 92). Therefore, if there is a difference in *altitude* between gun and target, when the gun is being laid, angle of site must be considered. Angle of site is the vertical angle between the horizontal of the gun and a line joining the gun and target. In direct fire, angle of site is automatically included when the gun is laid on the target. When conducting indirect fire, angle of site is combined with elevation for range to obtain quadrant elevation (elevation at which the gun is fired). If the target is above the gun, the angle of site is plus and is added to the elevation for range; if the target is below the gun, the angle of site is minus and is subtracted from the elevation for range. Angle of site is a function of true range and not any adjusted elevation.

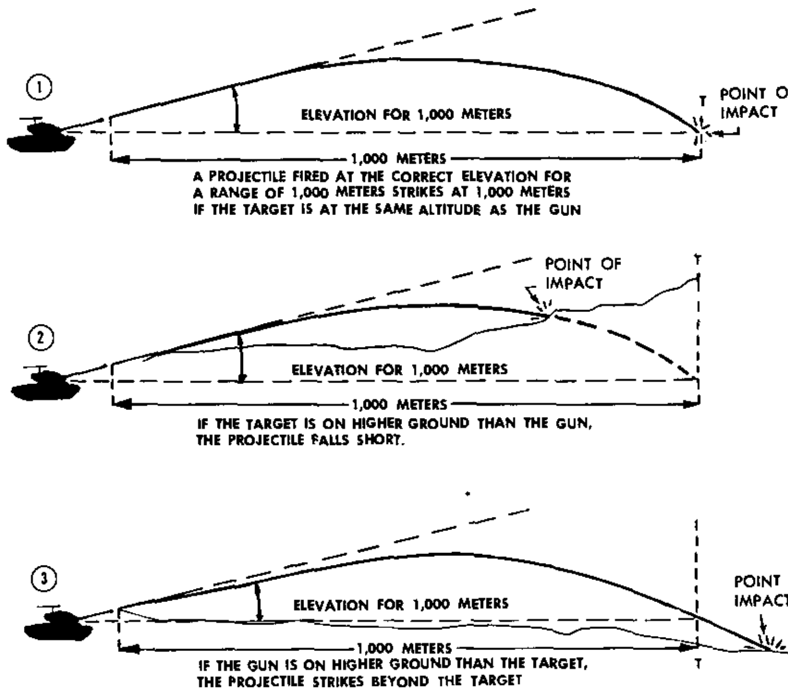


Figure 92. Effect of angle of site.

Note. Altitude (linear unit of measure) refers to height of the ground; *elevation* (angular unit of measure) refers to information used in laying the gun vertically.

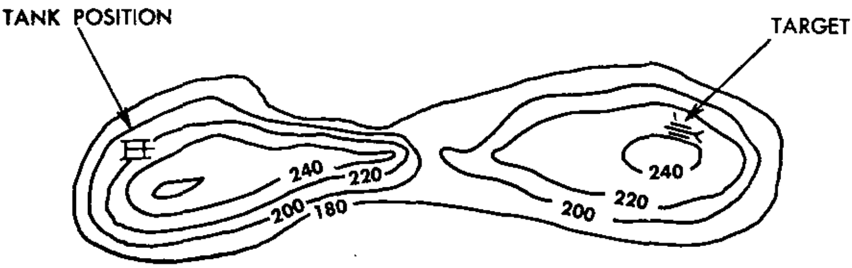
(*b*) *Determining angle of site.* Angle of site for this type of indirect fire is computed by use of a map and the mil relation. This method is simple and does not require special equipment. The procedure is as follows:

1. The firing position and target are plotted and the range is determined from the map scale to the nearest 100 meters (yards). In figure 93, the range is 3,000 meters.

2. The altitudes of the firing position and the target are determined by interpolating between contour lines to the nearest 5 meters (yards). The difference in altitude is obtained by subtracting the lower altitude from the higher. The range and the difference in altitude must be expressed in the same unit of measure (meters or yards). In figure 93, the difference in altitude is 15 meters.

3. Using the mil relation, the difference in altitude (W) is divided by the range (R) to obtain the angle of site

ANGLE OF SITE FROM A MAP



CONTOUR INTERVAL: 20 METERS

RANGE TO TARGET: 3,000 METERS (DETERMINED FROM MAP SCALE)

ALTITUDE OF TARGET: 235 METERS

ALTITUDE OF TANK: 220 METERS

DIFFERENCE IN ALTITUDE: 15 METERS

$$m = \frac{W}{R} \text{ OR } m = \frac{15}{3} = 5$$

ANGLE OF SITE = +5 MILS

Figure 93. Determining angle of site from a map.

(b). In figure 93, angle of site is 15 mils (target higher than firing position).

(c) *Average angle of site.* In situations where the target area, or large portions of it, is at approximately the same altitude, an average angle of site can be determined for various ranges. The appropriate one can then be used to save time during a firing mission.

(2) *Elevation for range.* Elevation for range is the mil angle at which the gun must be laid vertically, in relation to the horizontal, to enable a projectile to travel a prescribed distance. This information is obtained from a firing table and is always plus.

c. Deflection. Deflection is determined by computing the mil angle from a known line of zero deflection to a target, with both line and target in relation to the firing position (par. 175).

Section II. INDIRECT FIRE OF TANK PLATOON

172. Indirect Fire Missions

Two types of indirect-fire missions are assigned to tank units.

a. Fire for Neutralization. This is fire delivered to cause casualties and damage that will reduce enemy combat efficiency and prevent effective return fire. Area coverage is obtained by massing the fire of the unit. To conserve ammunition, adjustment is made by the center tank or base tank of the unit. The base tank of the tank platoon is tank No. 3. During adjustment, all tanks follow the commands, but only the base tank fires. When the adjustment is completed, the fire of the entire unit is placed on the target area.

Note. For prolonged periods of conducting indirect-fire missions, the No. 3 position should be rotated among all tanks to equalize tube wear as much as possible.

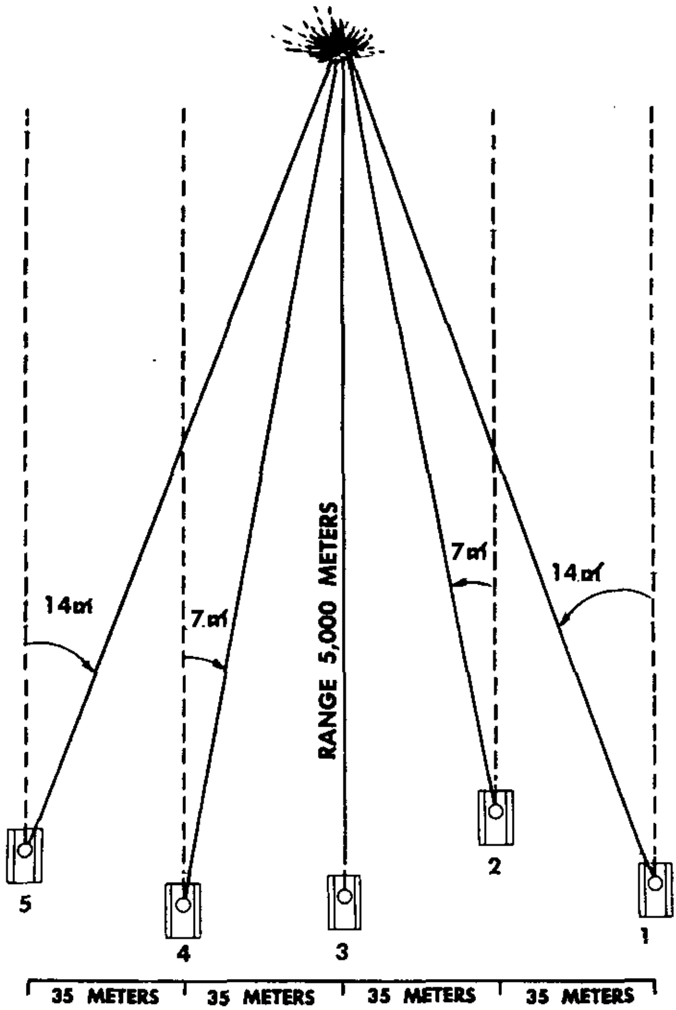
b. Fire for Destruction. This is fire delivered to destroy a point target such as an antitank gun or building. Bunkers and pillboxes are not profitable targets because of the high ammunition expenditure required to achieve effect. Adjustment is accomplished the same as in *a* above.

173. Sheaf

Distribution of fire depends on the sheaf or plane of fire of two or more tanks. The width of a sheaf is the lateral distance between the flank bursts. Tanks employ two types of sheaf for indirect fire:

a. Normal (Parallel) Sheaf. A normal sheaf is one in which the planes of fire are parallel. As tanks are normally positioned 35 meters apart, the width of a normal sheaf for a tank platoon is 140 meters. This type of sheaf is used for neutralization of area targets. Should the width of the target area be greater than the sheaf, the entire sheaf is shifted by a single command to all tanks.

b. Converged Sheaf. A converged sheaf is one in which the planes of fire converge on the target. This type sheaf is used for destruction of a point target. The sheaf of a tank platoon is converged on the plane of fire of the base tank by use of the mil relation to determine the necessary shift for the other tanks. With tanks positioned the same distance apart in a parallel sheaf, only one mil relation computation is required. The amount of shift for the two interior tanks is the same; for the two flank tanks, the figure is doubled. In figure 94, the shift for No. 2 and No. 4 is left 7 and right 7 respectively; for No. 1 and No. 5, left 14 and right 14.



$$\text{ɱ} = \frac{W}{R} = \frac{35}{5} = 7$$

NO. 1: LEFT 14
NO. 2: LEFT 7
NO. 4: RIGHT 7
NO. 5: RIGHT 14

Figure 94. Converged sheaf.

174. Organic Fire Control and Special Equipment and Personnel for Indirect Firing

a. Control. The platoon is the basic firing unit of the tank company. Indirect fire of the tank platoon is controlled at the firing position by the fire control officer (FCO), who normally is the platoon leader. He is responsible for positioning the tanks, laying the guns parallel, and directing the fire of the platoon. After receiving the minimum elevation from each tank crew, he determines minimum elevation for the platoon (par. 170*c*). He also determines angles of site to prominent terrain features in the target area. To save time during a fire mission, the fire control officer uses the appropriate average angle of site, or the angle of site to a terrain feature at approximately the same altitude and range as the target. Upon receiving an initial fire request or subsequent correction from the observer, the fire control officer directs fire by issuing necessary initial or subsequent fire commands to the tanks. The post of the fire control officer is where he can best control the fire of the platoon. Control is exercised by voice, wire, or radio. Wire should be provided to each tank to facilitate control and keep the radio net clear for communication with the observer and higher headquarters.

b. Special Equipment. Necessary fire direction equipment for the fire control officer includes a map, target grid, range scale, map pins, pencil and paper, coordinate scale, and a tabular or graphical firing table (GFT). This equipment is available through supply channels or can be quickly and easily improvised by the firing unit.

Map	Preferably of a scale of 1:25,000, but one of 1:50,000 can be used. Distribution in accordance with existing regulations.
Target grid	Requisition through publications channels.
Range scale	Construct from graphic scale of the map. A ruler graduated to the map scale may be used if available. The range scale or ruler also serves as a straightedge.
Map pins	Obtained through supply channels. Any type of straight pin can be used in lieu of map pins.
Coordinate scale	Requisition through supply channels or construct from map.
Recorder's log	*c*(2) below.
Firing table	Tabular firing tables for the weapon mounted on the tank are issued to each tank unit in accordance with existing regulations. Current TOE's of tank units do not provide graphical firing tables; however, certain equipment modification lists may authorize this item of equipment.

(1) *Target grid.* A target grid is graduated in meters or yards and is a device for converting the observer's target locations and corrections with respect to the

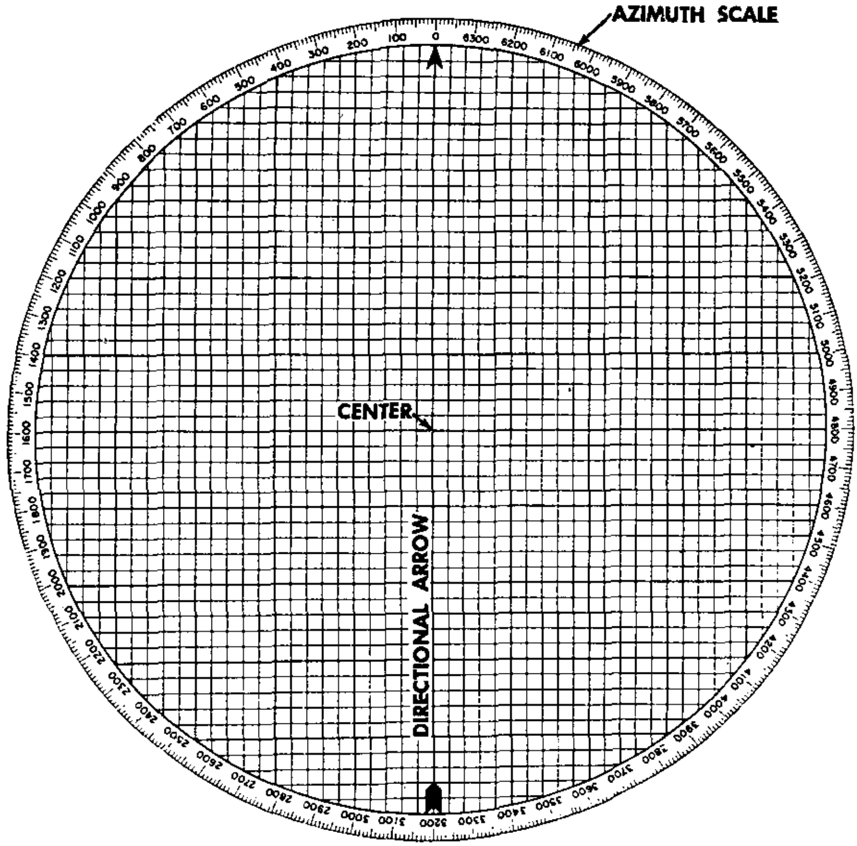


Figure 95. Target grid.

observer-target (OT) line, to target locations and corrections in firing, with respect to the gun-target (GT) line. An arrow extends across the grid, with the point of the arrow at the zero mark of the azimuth scale, and indicates the direction of the OT line. An azimuth scale is printed around the edge of the grid. The scale is graduated in a counterclockwise direction at 10-mil intervals from 0 to 6,400 mils, each 100 mils being labeled. When a target grid is used with a 1:25,000-scale map, the smallest graduation of the grid represents a distance of 100 meters (yards); with a 1:50,000 map, the smallest graduation represents 200 meters (yards) (fig. 95).

Note. As used in this manual, there is no differentiation between yards and meters in the use of the target grid for *observer corrections.*

(2) *Firing tables.* A firing table is a compilation of ballistic data; some of these data are used for laying tank guns from complete defilade positions.

(*a*) *Tabular firing tables* (TFT) (fig. 96). Tabular firing tables are ballistic data in book form, organized by ammunition types. There are a number of columns in each table, but for indirect fire of tank guns, only the following columns are used:

Range. Graduated in meters (yards) up to the maximum range (HE, HEP, and WP ammunition) in increments of 100. This is the basic column; all other columns in the table are compiled with reference to this column.

Elevation. Graduated in mils for the corresponding range. This column indicates the mil elevation necessary to fire a certain type round (projectile) at the range indicated.

Note. Must be combined with angle of site to determined quadrant elevation.

Drift. Graduated in a linear unit of measure and indicates the distance the projectile will drift from the line of fire at the corresponding range because of spin imparted to the projectile by rifling in the gun bore.

(*b*) *Graphical firing tables* (*GFT*) (fig. 97). Graphical firing tables are special type rules that consist of ballistic scales and an indicator. They are printed for a certain type of ammunition on both sides of the rule; one side for short range and the other side for long range firing. There are a number of scales on each side of the rule, but for indirect fire of tank guns, only the upper three scales and the appropriate drift scale, are used.

100-meter (-yard) scale. Graduated in mils and indicates the number of mils necessary to change *direction* 100 meters (yards) at the corresponding range.

Range scale. Graduated in meters (yards) up to the maximum firing range in varying increments. This is the basic scale; all other scales on the rule are compiled with reference to this scale.

Cartridge, HE, M71 and WP, M313
Fuzes, PD, M51A4 and M51A5*

Muzzle Velocity, 2700 f/s

Range	Elevation	Change in range for 1 mil change in elevation	Change in vertical height for 100 yd change in range	Drift	Time of Flight	Max ord	Range to max ord	Angle of fall	Remaining velocity
yd	mils	yd	ft	ft	sec	ft	yd	mils	f/s
5000	47.6	75	20	15	7.2	206	2712	66	1631
5100	49.0	74		16	7.3	217	2771	69	1612
5200	50.3	73		17	7.5	228	2830	71	1594
5300	51.7	72		18	7.7	240	2889	74	1575
5400	53.1	71		18	7.9	252	2949	76	1557
5500	54.6	70		19	8.1	264	3009	79	1538
5600	56.0	69		20	8.3	277	3069	82	1519
5700	57.5	68		21	8.5	290	3129	84	1501
5800	59.0	66		22	8.7	304	3189	87	1483
5900	60.5	65		23	8.9	318	3250	90	1465
6000	62.0	64		24	9.1	333	3311	93	1447
6100	63.6	63		25	9.3	348	3372	96	1429
6200	65.2	62		26	9.5	364	3434	100	1412
6300	66.8	61		27	9.8	381	3495	103	1395
6400	68.5	60		28	10.0	398	3557	106	1378
6500	70.2	59		29	10.2	416	3619	110	1362
6600	71.9	58		30	10.4	434	3681	113	1346
6700	73.6	57		32	10.6	453	3744	117	1330
6800	75.4	56		33	10.9	473	3807	121	1314
6900	77.2	55		34	11.1	494	3870	125	1299
7000	79.1	54		35	11.3	515	3933	129	1285
7100	81.0	53		37	11.6	537	3996	133	1270
7200	82.9	52		38	11.8	559	4060	137	1256
7300	84.8	51		40	12.0	583	4124	141	1243
7400	86.8	50		41	12.3	607	4188	146	1229
7500	88.8	49		43	12.5	632	4252	150	1216
7600	90.8	48		44	12.8	658	4316	155	1204
7700	92.9	48		46	13.0	685	4381	160	1192
7800	95.1	47		47	13.3	713	4446	165	1180
7900	97.2	46		49	13.6	742	4510	170	1169
8000	99.4	45		51	13.8	772	4575	175	1158
8100	101.6	44		53	14.1	802	4641	180	1148
8200	103.9	44		55	14.3	833	4706	185	1139
8300	106.2	43		56	14.6	865	4772	191	1130
8400	108.6	42		58	14.9	899	4838	197	1121
8500	111.0	41		60	15.2	933	4904	202	1113
8600	113.4	41		62	15.5	968	4970	208	1105
8700	115.9	40		65	15.7	1005	5036	214	1097
8800	118.4	40		67	16.0	1043	5102	220	1090
8900	120.9	39		69	16.3	1081	5168	226	1083
9000	123.5	38		71	16.6	1120	5234	232	1076
9100	126.1	38		74	16.9	1161	5300	238	1070
9200	128.8	37		76	17.2	1203	5366	244	1064
9300	131.5	37		78	17.5	1246	5432	250	1058
9400	134.3	36		81	17.8	1291	5497	256	1053
9500	137.1	36		84	18.0	1336	5563	262	1048
9600	139.9	35		86	18.3	1383	5629	268	1043
9700	142.7	35		89	18.6	1431	5694	275	1039
9800	145.6	34		92	18.9	1480	5759	281	1034
9900	148.6	34		94	19.3	1531	5824	287	1030
10000	151.6	33		97	19.6	1582	5889	294	1027

*These data are also applicable to Cartridge, HE, M71 armed with Fuzes, PD, M48A3 and T177E3.

Figure 96. Extract from tabular firing tables (FT 90–N–1).

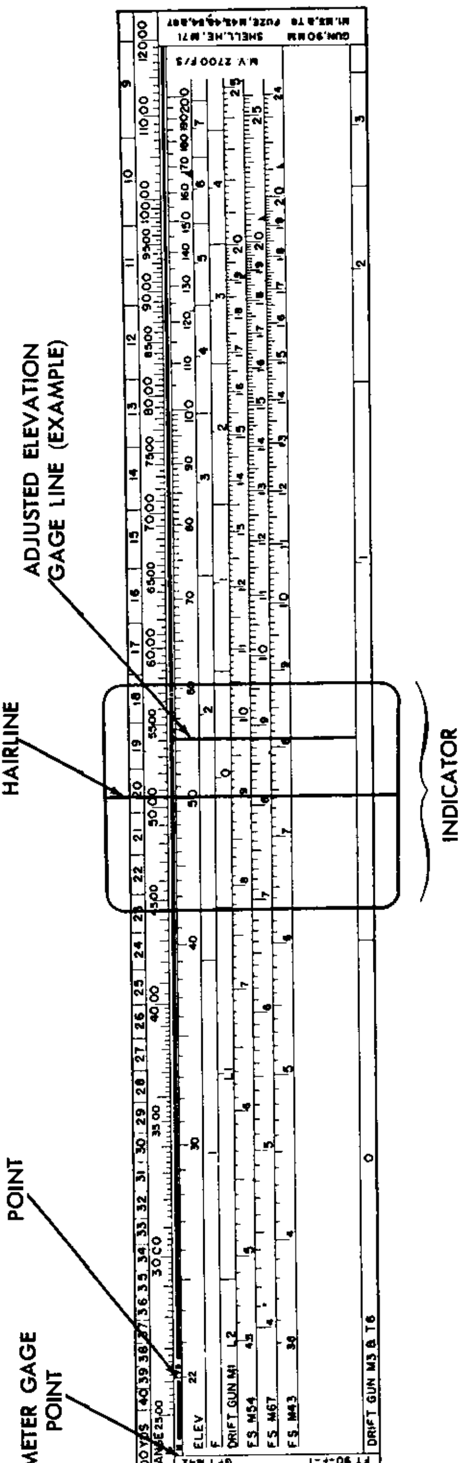


Figure 97. Graphical firing table (short range portion).

Elevation scale. Graduated in mils for the corresponding range. It indicates the mil elevation necessary to fire a certain type round (projectile) at the range indexed.

Note. Must be combined with angle of site to determine quadrant elevation.

Drift scale. Graduated in mils and indicates the correction in direction necessary to compensate for drift of the projectile from the line of fire ((*a*) above).

Note. On the left end of each GFT are two gage points labeled M and YD respectively. These points are used to convert meters to yards or vice versa. Move the hairline to the point marked YD. Then, using a straightedge and a finely sharpened pencil (4H drawing pencil, if available), draw a *conversion gage line* parallel to the hairline and over the point marked M. If the indicator window is too smooth for writing, sandpaper lightly. When a range is received in meters, move the conversion gage line to this reading and read the equivalent distance in yards under the hairline. This gage line can be used also to convert yards to meters by the reverse procedure. This may be necessary when determining angle of site and the map contour interval is in meters (par. 171*b*).

c. Special Personnel. Because special personnel required for indirect firing are not provided by tables of organization, it is necessary for the unit commander to designate qualified individuals for these positions from available personnel.

(1) *Observer.* Any observer who can communicate with the fire control officer can adjust tank fire. The observer establishes his observation post (OP) where he can observe the target area and adjust fire of the platoon. Radio is the normal method of communication with the firing position; however, wire should be laid for sustained operations in a static situation. Equipment for the observer includes maps, binocular, protractor, coordinate scale, paper, and pencils. As an aid to fire adjustment, the observer makes a terrain sketch of the assigned sector. The observer's sketch (fig. 99) is a schematic diagram of key terrain, the location of the OP, and reference points. As concentrations are fired, they are plotted for future reference.

(2) *Recorder.* The fire control officer requires one assistant to act as recorder. The recorder operates the radio or telephone and records platoon minimum elevation, angles of site, and each fire mission, including fire request, corrections, and all fire commands to the tanks. Every

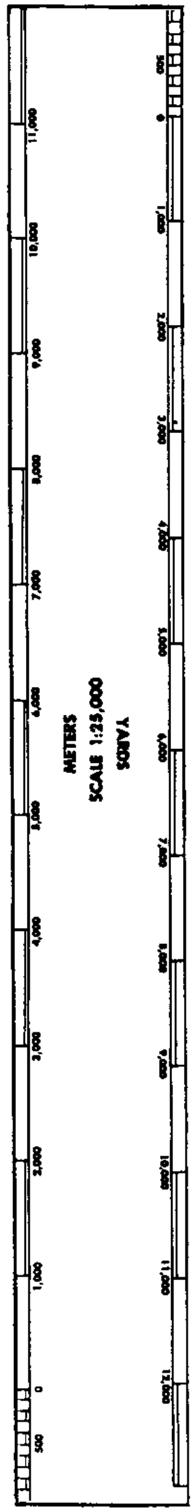


Figure 98. Range scale.

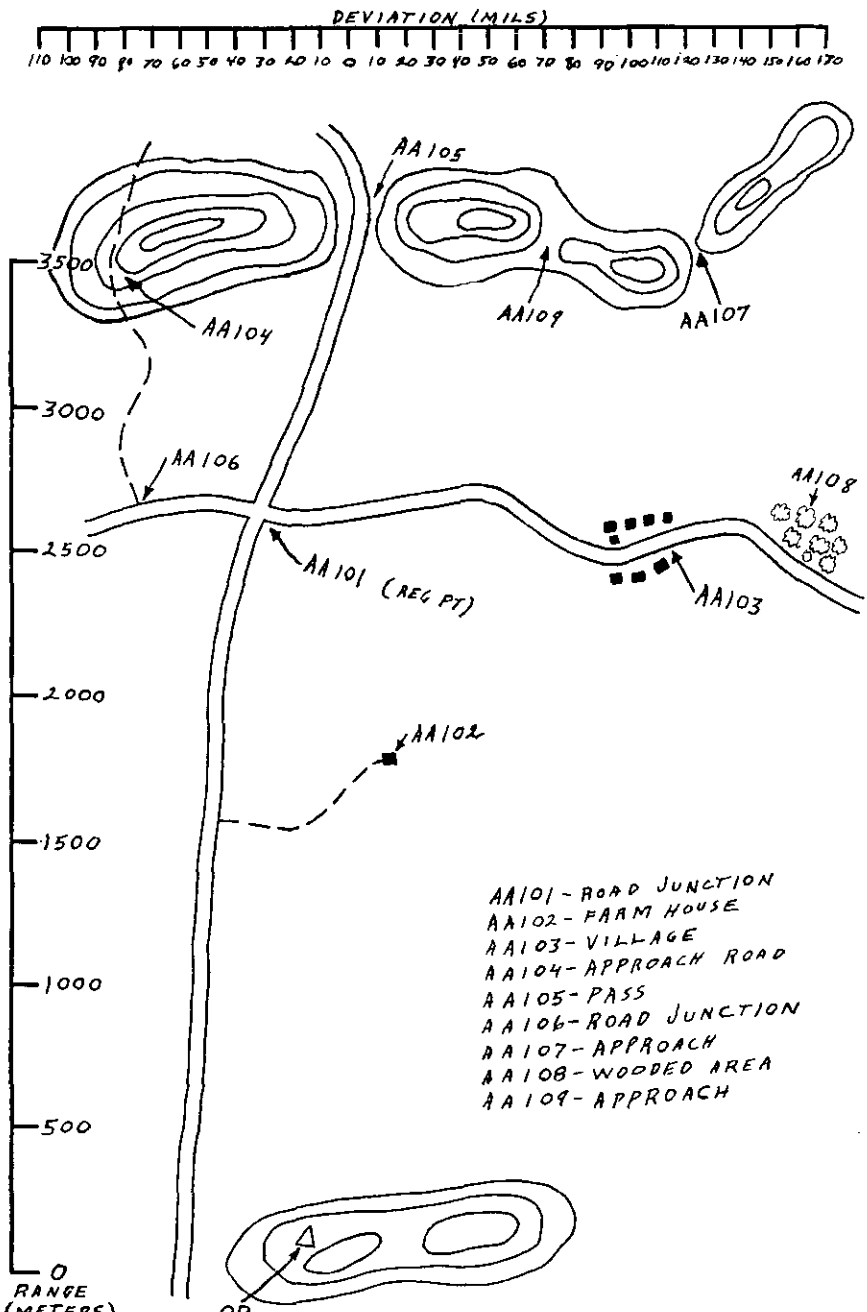


Figure 99. Observer's sketch.

RECORDER'S LOG

FIRING UNIT AND LOCATION	TIME	DATE	CONCENTRATION NO.	FIRING MAP
1ST PLAT, COC-84784558	0945	3 JAN 61	AA151	HOLLOW GROVE 1:25,000

FIRE REQUEST

BEARCAT 31 - FIRE MISSION: COORD 808895, AZ 5760, INF. PLAT. IN OPEN; WILL ADJUST

*REGISTRATION DATA		INITIAL TARGET DATA		INITIAL FIRE COMMAND
ADJUSTED QE	: +49	MAP RANGE: YARDS	: 7000	ALERT: PLAT ADJUST, NO 3
MINUS ANGLE OF SITE	: - 7.8	MAP RANGE: METERS	: 6400	
ADJUSTED ELEVATION	: + 41.2	**TOTAL RANGE CORRECTION	: +161 YD	AMMO (FUZE): HE
MAP RANGE: YARDS	: 4400	**RANGE TO BE FIRED	: 7050 YD	RANGE: QUADRANT + 70
MAP RANGE: METERS	: 3760	ELEVATION FOR RANGE TO BE FIRED	: 80.5	
**RANGE FOR ADJUSTED ELEVATION	: 4500 YD	ANGLE OF SITE	: -10.9	DIRECTION: DEFL 2950R
**TOTAL RANGE CORRECTION	: 100 YD	DE	: +70	DESCRIPTION: TROOPS
**K	: +23 YD	***DRIFT	: NR	
		DEFLECTION	: 2950 R	EXECUTION: AT MY CMD...FIRE

OBSERVER'S CORRECTIONS		SUBSEQUENT FIRE COMMANDS				
DEVIATION	RANGE	ALERT	AMMUNITION	RANGE	DEFLECTION	EXECUTION
R 140	D 400			QE + 66	2906 R	AMC - F
	A 200			QE + 68	2925 R	AMC - F
	REPEAT RG FFE	PLAT FM	3 RDS HE	QE + 68		AMC - F

FINAL TARGET DATA

COORDINATES	ANGLE OF SITE	QUADRANT ELEVATION	DEFLECTION
808898	-10.9	+68	2925R

AMMUNITION				REMARKS
STATUS	HE	HEP	WP	
ON HAND	340	—	80	OBSERVER ESTIMATED 10 CASULATIES; REMAINDER DISPERSED.
EXPENDED	18	—	—	
REMAINING	322	—	80	
RECEIVED	—	—	15	
ON HAND	322	—	95	

*NECESSARY ONLY FOR REGISTRATION MISSION

**NECESSARY ONLY WHEN TABULAR FIRING TABLE IS USED TO DETERMINE FIRING DATA

***WHEN NECESSARY

Figure 100. Recorder's log.

fire mission is assigned a concentration number for future reference. All information and data relevant to the fire mission are recorded in the recorder's log. The recorder's log (fig. 100) may be reproduced locally in sufficient quantities for use by the firing unit.

175. Determination of Initial Data for Indirect Fire

Information on target location is sent by the observer to the fire control officer by map coordinates or by reference to a known point (par. 177). The fire control officer determines data to engage a target by measuring the range and direction to the target in relation to the firing position, using his map and a target grid.

a. Registration. As soon as possible after positioning the tanks for indirect fire, the platoon should be registered. Registering the unit is to fire at a known point (registration point) until the point has been hit or the closest possible adjustment has been made. The purpose of registration is to establish a zero line of deflection (from which subsequent movements in direction are made) and to make corrections in firing data. These corrections are used to improved firing data in subsequent firing. However, even after applying corrections determined from registration, there will be the inherent probable error of dispersion among rounds fired with the same data. Corrections determined from registration data are the most accurate that can be obtained for firing. Therefore, registration should be conducted as frequently as possible, within ammunition and other limitations, to provide corrections. A registration point is selected by the observer or the FCO (although it must be mutually known) and should be an easily distinguishable terrain feature or some other object that cannot be moved or easily destroyed by fire and in the approximate center of the firing sector. To register the tank platoon, the observer transmits a fire request to the fire control officer. The fire request must contain enough information to inform the fire control officer of the location of registration point (normally sent by map coordinates), the azimuth from the observer to the point selected, and the fact that it is a registration mission.

Example.

Identification of observer	THIS IS FOXTROT 4
Warning	FIRE MISSION
Location of target and azimuth	COORDINATES 747962, AZIMUTH 1240
Nature of target	REGISTRATION POINT*
Control	WILL ADJUST

*If more than one registration point is to be used, the observer states REGISTRATION POINT ONE (TWO, THREE, etc.).

As all the guns are laid parallel in the general direction of fire (par. 169), only the base tank fires the registration, and the remaining tanks merely follow the commands. The base tank fires with the deflection and quadrant elevation announced by the fire control officer. The observer must sense each round fired and transmit corrections to the fire control officer until registration has been completed. On completion of the registration, all gunners zero their azimuth indicators without disturbing the lay of the guns and place out aiming stakes as reference points (par. 77). Tank guns are now parallel in the registration point direction and all deflection shifts are made from this reference point. The last quadrant fired is the adjusted quadrant elevation. The fire control officer plots the firing position and the registration point on his firing map, connecting the two points with the *registration point line.* He then draws an *azimuth* (grid north) *index* (fig. 101) for the registration point by placing the center of the target grid over the registration point, rotating the target grid until the direction arrow is parallel to the north south grid lines of the map, and drawing the azimuth index on the map opposite the zero of the azimuth scale.

b. Correcting Firing Data.

(1) *Adjusted elevation for range.* Regardless of the type firing table used for determining firing data, the adjusted elevation for range, based on registration firing, must first be determined before the firing data can be corrected. As quadrant elevation is the algebraic sum of firing table elevation and angle of site, it is necessary for the FCO to subtract, algebraically, the value of the angle of site from the adjusted quadrant elevation to obtain the adjusted elevation.

Examples.

(*a*)	Adjusted QE		74
	Minus angle of site		—(+6)
	Adjusted elevation	=	68
(*b*)	Adjusted QE		74
	Minus angle of site		—(—6)
	Adjusted elevation	=	80

(2) *Use of the adjusted elevation with a tabular firing table.* If a tabular firing table is being used to determine firing data, it is necessary to determine the range correction (*K*) per 1,000 meters (yards) for computing subsequent quadrant elevations. *K* is a constant expressed as plus or minus so many meters (yards) per thousand meters (yards) and represents the ratio of adjusted range to map range. To determine *K*, first determine the range in the firing table corresponding to the adjusted elevation, interpolating, if necessary, to the nearest 50 meters (yards). Then establish *K* by subtracting the measured map range to the registration point from the range corresponding to the adjusted elevation, or vice versa, depending on which is the greater. Divide the result by

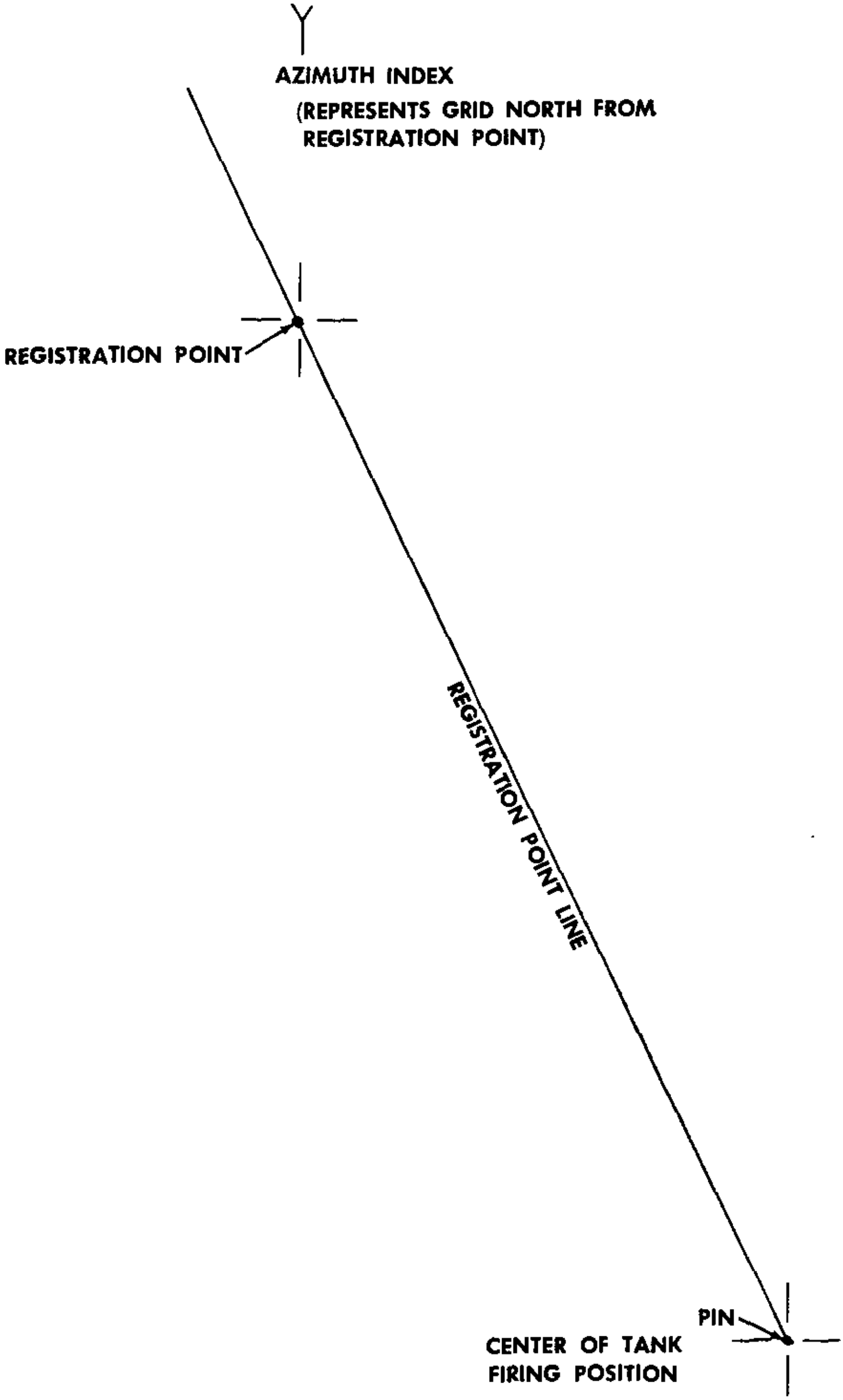


Figure 101. Initial plotted locations.

the range to the registration point (in thousands to the nearest hundred). If the measured map range is greater, then K is minus; if it is smaller, then K is plus.

Note. Record K in the recorder's log (fig. 100) for each target engagement when a tabular firing table is used to determine elevation for range.

To apply K, multiply it by the map range to the new target (in thousands to the nearest hundred). The result is the *total range correction* for the new target, which is added algebraically to the *map range* to the new target to obtain the *range to be fired*. Enter the firing table at this range to obtain the corresponding elevation. Add or subtract (as appropriate) the angle of site, from the firing position to the new target, to this elevation to obtain the quadrant elevation.

Note. If necessary, obtain drift by starting with the figure corresponding to the adjusted elevation and the range corresponding to this elevation; however, deflection and angle of site are determined using the measured map range, as these factors are a function of true range and not elevation.

Example.

REGISTRATION DATA

Map range		6,500 yards
Adjusted elevation		74 mils
Range corresponding to the adjusted elevation (74 mils).	=	6,750 yards
Map range	=	6,500 yards
Total range correction	=	+ 250 yards

$$\text{Range correction } (K) = \frac{\text{Total range correction}}{\text{Map range (in 1,000's)}}$$

$$K = \frac{+250}{6.5}$$

K = +38 yards (per 1,000 yards of range)

NEW TARGET DATA

Map range		7,200 yards
Total range correction	=	$K \times$ range (in 1,000's)
	=	$+38 \times 7.2$
	=	+274 yards
Range to be fired	=	Map range + total range correction
	=	7,200 + 274
	=	7,500 yards (rounded off to nearest 50 yards)

Elevation corresponding to range to be fired (obtain from firing table).	=	+88.8 mils
Angle of site from gun to target (assumed).	=	+6
Quadrant elevation	=	+94.8 or +95 mils

(3) *Use of the adjusted elevation with a graphical firing table.* If a graphical firing table is being used, slide the indicator along the range scale until the hairline is directly over the map range to the registration point. Then draw an *adjusted elevation gage line* on the indicator through the adjusted elevation and parallel to the hairline. The GFT is now prepared for firing on other targets from this same firing position. Slide the indicator until the hairline is directly over the map range and read the elevation under the adjusted elevation gage line. To obtain quadrant elevation, add the angle of site from the firing position to the new target, to this elevation.

Note. If necessary, drift also is read under the adjusted elevation gage line, but the 100-meter (-yard) scale is still read under the hairline, and angle of site is determined using the range under the hairline, as these factors are a function of true range and not elevation.

c. Target Location by Reference to a Known Point. A known point may be a registration point, concentration, or any point known by the observer and FCO. Initial data to engage a target located with reference to a known point are determined in the following manner (using a registration point example) :

(1) *Using a tabular firing table.*

(*a*) The observer determines the necessary shift from the registration (known) point for both direction and range in meters (yards) and the azimuth of the observer-target line in mils. He then transmits his request for fire to the fire control officer (pars. 176–179).

(*b*) The fire control officer pins the center of the target grid to the known point designated by the observer as the point from which a shift is to be made (fig. 102). He then rotates the target grid until the azimuth announced by the observer is opposite the azimuth index. By noting the direction in which the arrow is pointing, he knows in which direction the observer is looking at the target. When the observer announces LEFT (RIGHT), ADD (DROP), the fire control officer measures the shift from the known point in the direc-

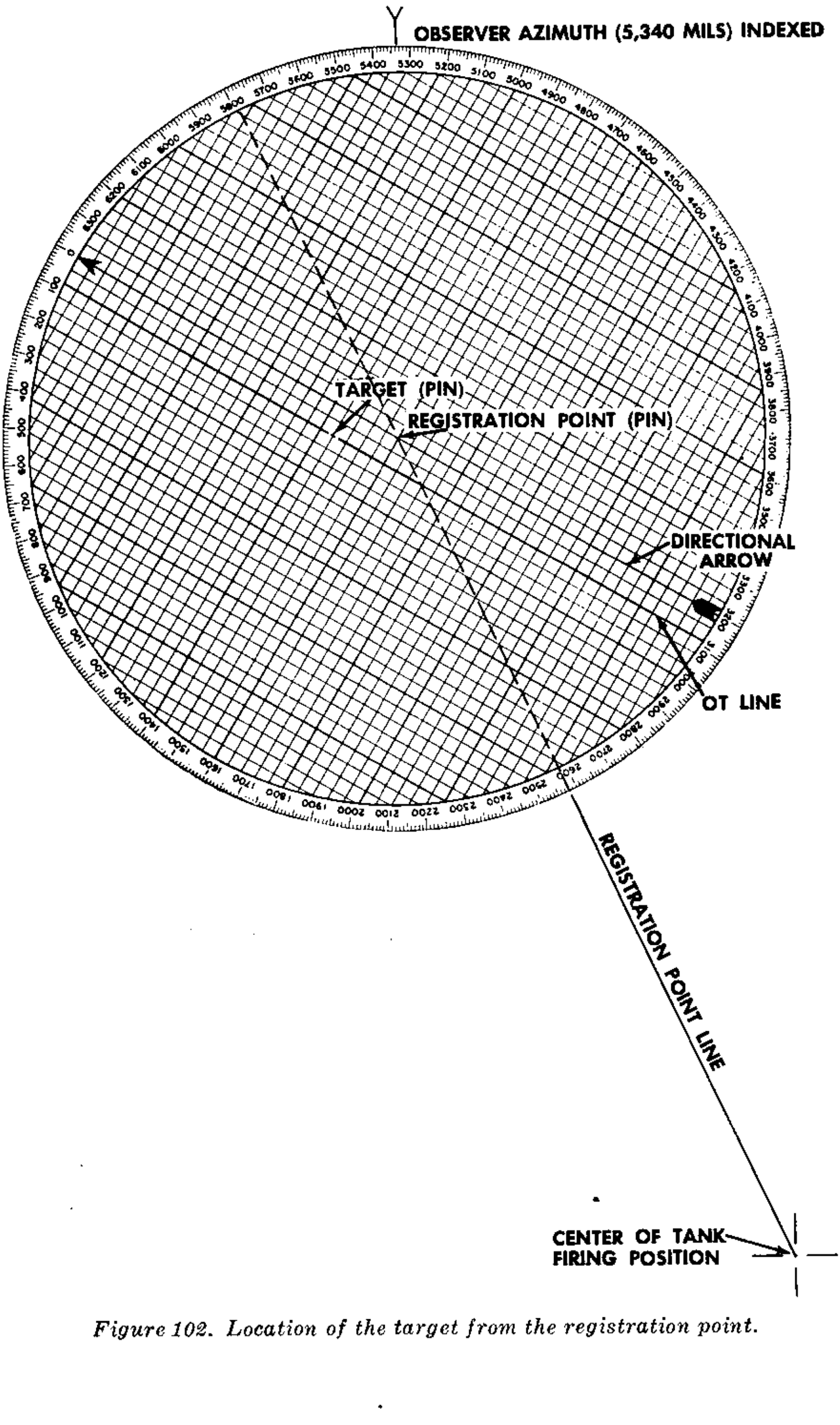


Figure 102. Location of the target from the registration point.

tion requested and places a map pin at that location. This establishes the location of the target. The fire control officer need not know the location of the observer; however, he must know the observer-target (OT) line. Once the target has been plotted, the fire control officer knows that the OT line is the line that runs through the target location, paralleling the direction arrow of the target grid (fig. 102).

(*c*) By inspecting his map, the fire control officer determines the difference in altitude of the guns and target, if any, and computes angle of site (par. 171*b*(2)). Range is determined by measuring the distance from the firing position to the target with a range scale (fig. 103) or ruler graduated to the scale of the map. *K*, as determined by registration, is multiplied by this range (in thousands to the nearest hundred) to determine the range to be fired (*b*(2) above).

Note. It may be necessary to determine range in both meters and yards, e.g., if the firing table is graduated in yards and map altitudes (used to determine angle of site) are in meters.

Elevation for range is obtained from the appropriate firing table to the nearest tenth of a mil (fig. 96). To determine elevation for range with a tabular firing table, read down the range column to the correct range (range to be fired) and then horizontally to the elevation column. If range is not an even 100, round off to the nearest 50 and interpolate between columns as necessary. The elevation for range is combined with angle of site, determined to the nearest tenth of a mil, to obtain quadrant elevation (QE).

(*d*) Deflection is determined by converting the direction shift from meters (yards) to mils. This is done by use of the mil relation. The fire control officer measures the perpendicular distance from the *registration point line* to the new target (fig. 104). This figure becomes the *W* factor of the mil relation. The range from the firing position to the target is rounded off to the nearest 100 meters (yards) and used as the *R* factor; e.g., a range of 5,640 meters (yards) would be converted to an *R* factor of 5.6. To determine the mil angle (*ɱ*), *W* is divided by *R*. The resulting mil angle is the direction shift. If the target is *left* of the registration point line, the direction shift in mils is the deflection (azimuth indicator reading). If the target is *right* of the registration point line, the di-

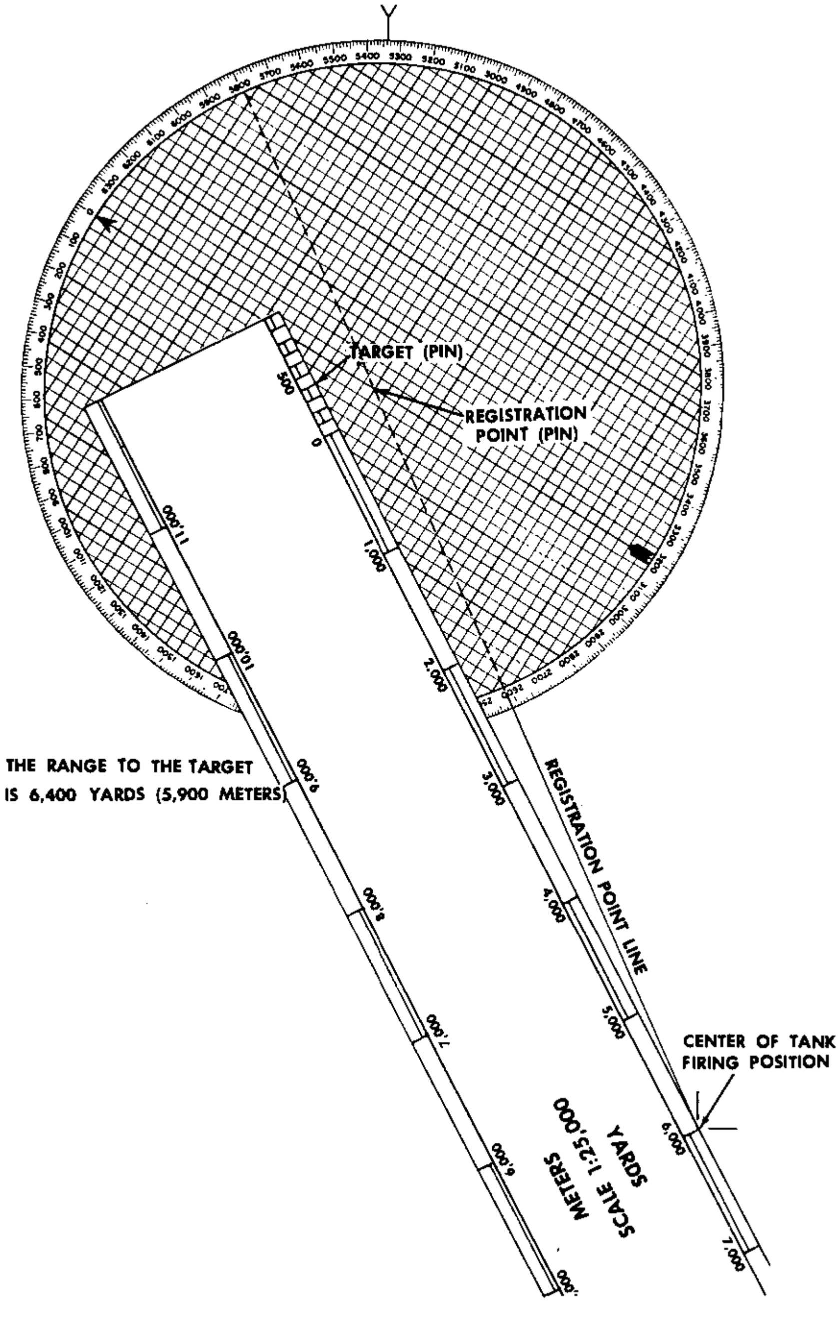
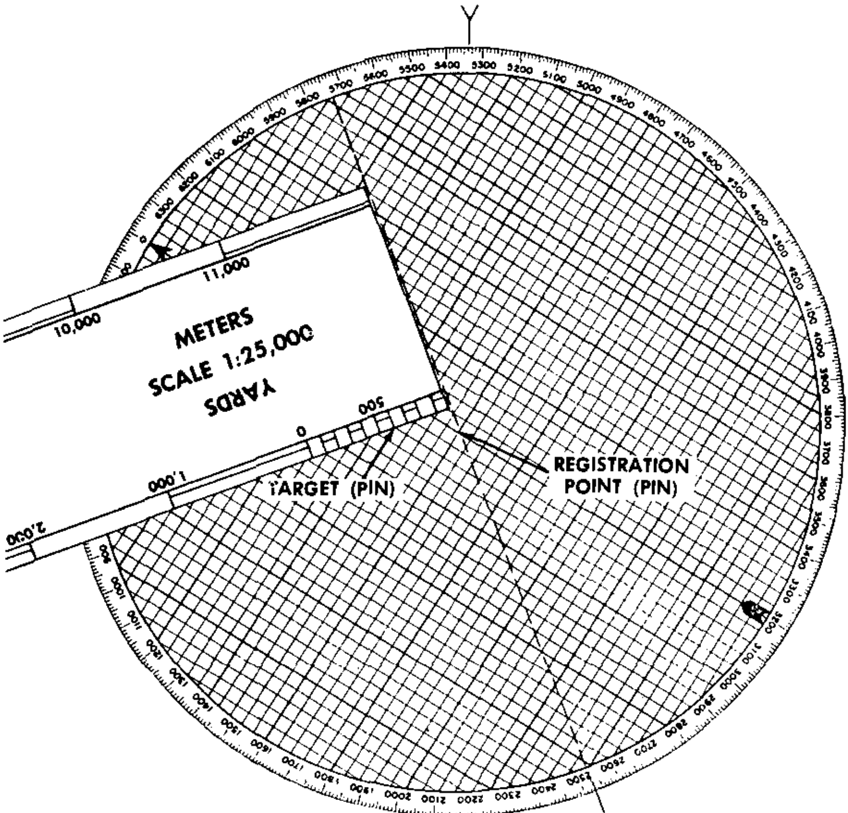


Figure 103. Determining range to a target.



MEASURED DISTANCE FROM REGISTRATION POINT LINE: 400 YARDS (W)

MEASURED RANGE TO TARGET: 6,400 YARDS (R)

Using the mil relation, $\frac{W}{R\not{m}}$: $\not{m} = \frac{W}{R} = \frac{400}{6.4} = 62.5 = 63$ mils

Because the target is left of the registration point line, deflection is 63 L. Had this target been right of the registration point line, the mil angle would be subtracted from 3,200 to obtain the deflection. For example: deflection = 3,200 − 63 = 3,137 right.

Figure 104. Determining deflection to the target.

rection shift in mils must be subtracted from 3,200 to determine the deflection, because of the manner in which the azimuth indicator is graduated (fig. 33).

(*e*) The drift correction is determined by reading the appropriate portion of the tabular firing table (i.e., read down the range column to the correct range and then read horizontally to the drift column) and converting the amount of drift in a linear unit of measure to mils, by use of the mil relation. Before using the mil relation, make certain the drift (W) is in the same unit of measure as the range (R). When the amount of drift in mils is determined, round off this figure to the nearest whole mil, if fractional (same as QE; par. 183), and *add* this figure to deflection. The same drift correction is used with all subsequent deflection changes for firing at a particular target. As drift for projectiles fired from tank guns is always to the right, it is always *added* to deflection. If this results in a figure greater than 3,200, it must be subtracted from 3,200 to determine the deflection or azimuth indicator reading.

Note. Computation of a drift correction is necessary only when firing unobserved fire at a target that has not previously been taken under fire or when, in the opinion of the FCO, such a correction is necessary to ensure sufficient accuracy of the first round in the adjustment to enable sensing by the observer.

(2) *Using a graphical firing table.* If a graphical firing table is used to determine firing data, the general procedure is the same as with a tabular firing table, but elevation for range and deflection are determined as follows:

(*a*) *Elevation for range.* Range to the new target is determined in the same manner as stated in (1) (*c*) above. To obtain elevation for range, slide the indicator of the graphical firing table along the range scale until the target range is indexed under the hairline (round off range to the nearest 50). The figure under the *adjusted elevation gage line* (as determined by registration (*b* (3) above) on the elevation scale is the mil elevation for the indexed range. It is necessary to interpolate this scale to the nearest mil.

(*b*) *Deflection.* To determine deflection, the fire control officer measures the perpendular distance from the *registration point line* to the new target, in the same manner as stated in (1) (*d*) above. To convert this direction shift in meters (yards) to a direction shift in mils, the fire control officer uses the 100-meter (-yard) scale at the top of the graphical firing table. With the range to the target indexed on the range scale, read up the *hairline* to the 100-meter (-yard) scale. The figure indexed is the number of mils the gun must be traversed to change the strike of the projectile 100 meters (yards) in *direction*. (If the hairline falls nearer to the line between the figures than to a figure on the 100-meter (-yard) scale, use .5 mil more or less than the indexed figure, as appropriate.) The mil reading obtained is multiplied by the direction shift in hundreds of meters (yards) to determine the direction shift in mils. (If the distance from the registration point line to the target is not in even hundreds of meters (yards), e.g., 60 meters (yards), the figure indexed on the 100-meter (-yard) scale is multiplied by the fraction of 100 meters (yards) the distance represents, e.g., 17 $\times$ .6 equals 10.8 or 11 mils.) The direction shift in mils is converted to a deflection as explained in (1) (*d*) above.

(*c*) *Drift.* The amount of drift is determined by reading the figure under the hairline on the appropriate drift scale. These scales are graduated in mils; therefore, the amount determined is added to deflection without further computation.

Note. The drift correction is necessary only under the conditions stated for the tabular firing table.

d. Coordinate Method of Target Location. When a target can be located on a map, an observer may send its location by grid coordinates of at least six digits. Data to engage a target from map coordinates are determined as follows:

(1) The fire control officer plots on his map the coordinates of the target, places a map pin through the center of the target grid, and pins it to the coordinates of the target. After establishing the azimuth index for the target location, he rotates the target grid to index the azimuth transmitted by the observer. The direction arrow of the target grid is now oriented in relation to the observer-target (OT) line.

(2) Range is determined by measuring the distance between the target and the firing position. Quadrant elevation is determined by one of the methods outlined in *c* above.

(3) The direction shift in meters (yards) is determined by

measuring the perpendicular distance from the registration point line to the target. This direction shift in meters (yards) is then converted to a deflection using one of the methods outlined in *c* above.

e. Concentrations. All fire missions are assigned a concentration number by the fire control officer, as specified by the controlling headquarters. After each mission is completed, the adjusted firing data are entered in the recorder's log, under final target data, to establish additional known points in the target area. Should a target appear closer to a previously fired concentration than to the registration point, the observer may locate the target by reference to that concentration. Additionally, when there is renewed enemy activity in the area of a concentration, the observer may request that the concentration be refired. The fire control officer uses the same procedure in determining firing data for a shift from a concentration as in shifting from any other known point (*c* above).

Note. The observer must include the azimuth of the OT line when requesting a concentration be refired in the event adjustment of fire is necessary.

Section III. INITIAL FIRE REQUEST

176. Elements of Initial Fire Request

To obtain fire on a target, the observer transmits an initial fire request to the FCO. The initial fire request for tank indirect fire is the same as the request for artillery and mortar fire (FM 6–135). The elements of the initial fire request are announced in the following sequence:

a. Identification of observer (call words).

b. Warning (FIRE MISSION).

c. Location of target and azimuth (par. 177).

d. Nature of target (size, type, and activity).

e. Unusual requirements (omitted in tank indirect fire).

f. Type of control (par. 178).

177. Location of Target and Azimuth

Target location for tank indirect fire is determined by one of the following methods:

a. Coordinates. When the observer can locate the target on his map, he may send coordinates (at least 6 digits) followed by the OT azimuth, *for example:* COORDINATES 345876, AZIMUTH 2,200. The observer determines the azimuth in mils to the target from his position by use of a compass, a map, or reference to a point of known azimuth. This is a rapid and simple method of target location, and is usually more accurate than a large shift from a reference point. In the initial fire request, the azimuth is announced to the nearest 10 mils, e.g., AZIMUTH 4,340. When the azimuth to a reference point is measured, the azimuth to a target may be determined as follows: Measure the angle in mils between the reference point and target. If the target is to the left of the reference point, the angle is subtracted from the azimuth of the reference point; if the target is to the right of the reference point, the angle is added to the azimuth of the reference point.

Examples. 1. The grid azimuth to the reference point is known to be 970 mils. A target is located 80 mils to the left of the reference point. The azimuth to the target is 890 (970–80) mils.

2. The grid azimuth to the reference point is 4,140 mils. A target appears 200 mils to the right of the reference point, as measured with the binocular. The azimuth to the target is 4,340 (4,140 + 200) mils.

When no means of measuring is available, the observer must estimate the azimuth. Azimuths announced in the initial fire request are considered to be accurately determined grid azimuths unless otherwise specified. *For example:* AZIMUTH 4340 MAGNETIC or AZIMUTH 1400 ESTIMATED.

b. Reference to a Known Point. The observer may locate the target by reference to a known point, such as a registration point or a concentration. The reference is given as a shift in direction and range, in meters (yards), preceded by the azimuth from the observer to the new target. *For example:* FROM REGISTRATION POINT, AZIMUTH 750, RIGHT 80, ADD 600; or, FROM CONCENTRATION CHARLIE BRAVO 103, AZIMUTH 450, LEFT 100, DROP 400.

(1) *Direction.* The observer determines the direction correction by first measuring the angle in mils from the known point to the target. Then by use of the mil relation, the mil angle ($\cancel{m}$) is multiplied by the distance from the observer to the known point (R) to obtain the direction correction (W) (fig. 105). The direction correction is sent to the nearest 10 meters (yards). When the direction of the target is the same as that of the known point, a direction correction is omitted from the fire request.

(2) *Range.* The range correction is determined by estimat-

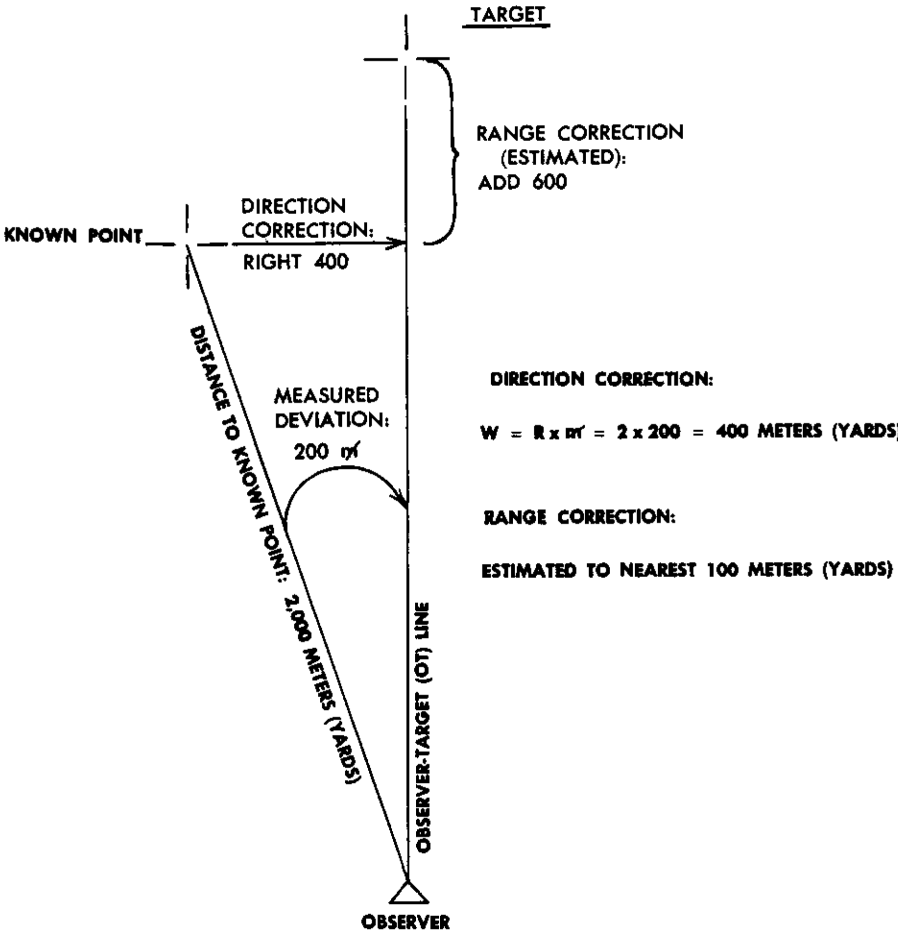


Figure 105. Target location by reference to a known point.

ing the distance along the OT line to the target from a point where a perpendicular line from the known point intersects the OT line (fig. 105). The range correction is sent to the nearest 100 meters (yards). If the range to the known point and target are estimated to be the same, it is announced as REPEAT RANGE.

c. Marking Round. Once a unit has established known points, it may be necessary to mark these points at a later time. For example, a member of an infantry unit may request fire from the tank unit without knowing the location of any point of reference used by the firing unit. In this situation he would request that a marking round be fired by the firing unit to show a point or points of reference, such as MARK REGISTRATION POINT.

Once the firing unit marks a known point, the observer can then locate targets by shifting in direction and range from this known point (*b* above).

178. Type of Control

Type of control is the last element of the initial fire request and indicates to the FCO the observer's method of controlling the fire. Types of control the observer may employ in area fire are—

Type of control	*Meaning*
WILL ADJUST	"Adjustment is necessary before massing the fire; I am in position to observe; you may fire when ready."
FIRE FOR EFFECT	"I have the target located accurately (within 50 meters (yards)). I want massed fire placed on the target now." *Note.* When engaging targets at a previously fired concentration, FIRE FOR EFFECT may be used as the control element without adjustment; otherwise, adjustment is usually necessary.
AT MY COMMAND	"Hold your fire until I give a command to fire." Used when the observer wishes to control the time of firing. May be used in conjunction with the types of control listed above, e.g., AT MY COMMAND, FIRE FOR EFFECT. When using this control element, the observer must command FIRE before the guns will be fired. To release them from this control before a mission is completed he states WHEN READY.
CANNOT OBSERVE	"I have a target I believe important enough to warrant fire without adjustment; however, I am not in a position to observe."

179. Examples of Initial Fire Request

Identification	THIS IS BRAVO 7	THIS IS DELTA 5	THIS IS TANGO 2
Warning	FIRE MISSION	FIRE MISSION	FIRE MISSION
(From FCO)	(SEND YOUR MISSION)	(SEND YOUR MISSION)	(SEND YOUR MISSION)
Location of target and azimuth	COORDINATES 987456, AZIMUTH 1200 ESTIMATED	FROM REGISTRATION POINT, AZIMUTH 6150, RIGHT 60 ADD 400	CONCENTRATION BRAVO ALFA 101, AZIMUTH 850
Nature of target	COMPANY OF INFANTRY IN WOODS	ANTITANK DUG IN	BATTLE OF INFANTRY IN ASSEMBLY AREA
Type of control	WILL ADJUST	WILL ADJUST	FIRE FOR EFFECT

Section IV. INITIAL FIRE COMMANDS FOR INDIRECT FIRE

180. General

Indirect fire of tanks is directed by fire commands from the fire control officer. The FCO bases his initial fire command on the initial fire request of the observer. The initial fire command for indirect fire consists of six elements and is issued in the same sequence as initial fire commands for direct fire (par. 95).

181. Alert Element, Indirect Fire Command

This element alerts the unit for the fire mission and designates the unit or tanks to fire. When an adjustment is necessary, the base tank fires; the remainder of the unit follows the commands but does not fire. This is announced as PLATOON ADJUST, NUMBER 3. If no adjustment is necessary, the command is PLATOON or the number of the tanks to fire followed by FIRE MISSION. The alert element indicates also whether volley or salvo fire will be employed.

Note. In radio communication the call words are used in place of unit designation or tank number.

a. Volley Fire. Volley fire is firing of a specified number of rounds by each firing tank. Once the initial command to fire has been given the indicated number of rounds are fired rapidly without further command. Volley fire normally is employed to attain destruction of the target; unless otherwise specified, it is the type fire employed.

b. Salvo Fire. Salvo fire is successive firing at a prescribed time interval by two or more tanks. The command for salvo fire is SALVO RIGHT (LEFT). On the command to fire, the right (left) flanks tank of the unit fires, followed by each adjoining tank at 2-second intervals. To vary the firing interval, it is necessary to specify the time. *For example:* PLATOON, SALVO RIGHT, 5-SECOND INTERVAL.

182. Ammunition Element, Indirect Fire Command

The ammunition element is announced with standard direct-fire terminology for projectile and fuze. In addition, when the unit is to fire for effect, the number of rounds to be fired is announced. *For example:* 4 ROUNDS HE or 3 ROUNDS HEP.

183. Range Element, Indirect-Fire Command

The range element is announced as a quadrant elevation to the nearest mil when an elevation quadrant is used. If a gunner's quadrant is used, quadrant elevation may be announced in tenths of mils at the descretion of the fire control officer. With the elevation quadrant, fractions of .5 and greater are rounded off to the next higher whole mil and fractions of .4 and less to the next lower whole mil. Quadrant elevation is announced as QUADRANT PLUS (SO MUCH) if plus and QUADRANT MINUS (SO MUCH) if minus.

184. Direction Element, Indirect-Fire Command

a. The direction element is announced as a deflection (azimuth indicator reading) left or right of the registration point (zero deflection). Thus, when a target is 124 mils left of the registration point (and no drift correction is used), direction is announced as DEFLECTION 124 LEFT: or if right of the registration point, as DEFLECTION 3076 RIGHT.

b. To fire a converged sheaf, such directions are included in the direction element and each tank is given a separate deflection. *For example:* CONVERGED SHEAF, NUMBER ONE, DEFLECTION 3090 RIGHT; NUMBER TWO, DEFLECTION 3083 RIGHT; NUMBER THREE, DEFLECTION 3076 RIGHT; NUMBER FOUR, DEFLECTION 3069 RIGHT; NUMBER FIVE, DEFLECTION 3062 RIGHT. This type of element will be used only in firing for effect.

185. Description Element, Indirect-Fire Command

The target description element is announced for information to give added incentive to tank crews and to maintain uniformity with the initial fire command for direct fire. Brief descriptions are used, e.g., "infantry in the open" is announced as TROOPS.

186. Execution Element, Indirect-Fire Command

Tanks fire on the command FIRE, which is announced by the fire control officer. The FCO announces AT MY COMMAND and withholds the command to fire until the commanders of all firing tanks have signified readiness by giving the proper hand signal or announcing READY, as prescribed.

187. Examples of Initial Fire Command, Indirect Fire

Alert	PLATOON ADJUST, NUMBER 3	PLATOON, FIRE MISSION
Ammunition	HEP	2 ROUNDS HE
Range	QUADRANT PLUS 116	QUADRANT PLUS 88
Direction	DEFLECTION 2814 RIGHT	DEFLECTION 66 LEFT
Target	TROOPS	TRUCKS
Execution	AT MY COMMAND ___FIRE	AT MY COMMAND __FIRE

Alert	NUMBER 2, 3, AND 4, FIRE MISSION	PLATOON, SALVO RIGHT
Ammunition	3 ROUNDS HE DELAY	1 ROUND HEP
Range	QUADRANT PLUS 52	QUADRANT PLUS 120
Direction	DEFLECTION 44 LEFT	DEFLECTION 1234 LEFT
Target	ANTITANK	TROOPS
Execution	AT MY COMMAND ___FIRE	AT MY COMMAND ___FIRE

188. Crew Firing Duties, Indirect Fire

To obtain speed in firing while retaining accuracy, tank crews perform firing duties in a logical sequence as the fire command is issued. Each element of the fire command requires specific action by the crew.

a. Alert. All tank crews designated to fire or adjust are alerted for the fire mission. Crewmen assume their positions and prepare to follow commands. Each element of the command is repeated by the tank commander, and for the alert element to the crew, the tank commander announces GUNNER.

b. Ammunition. All loaders select the designated ammunition, setting the fuse if necessary. Only the tank guns to fire are loaded; commanders of nonfiring tanks announce DO NOT LOAD prior to repeating type of ammunition. Loaders announce UP after loading.

c. Range. All gunners index the announced quadrant elevation on the quadrant but do not center the bubble at this time.

d. Direction. All gunners traverse in the appropriate direction until the announced deflection is indexed on the azimuth indicator. On completion of traverse, each gunner elevates or depresses the gun until the quadrant bubble is centered. The gun is now laid for range and direction.

***Caution:* The quadrant bubble must be centered after the gun is loaded and laid for direction to insure an accurate lay. The manual controls are used for all laying during indirect firing.**

e. Description. After the gun is laid and the description is announced, gunners announce READY to tank commanders. Tank commanders then signify readiness by giving the proper hand signal or announcing READY to the FCO as previously prescribed.

f. Execution. After announcing AT MY COMMAND and receiving the appropriate ready signal from all tank commanders, the FCO commands FIRE. Gunners announce ON THE WAY and fire; the FCO sends ON THE WAY to the observer. After the initial round has been fired, the actions of the crews depend on the type fire specified in the command. When more than one volley has been ordered, the loader loads immediately after the gun is fired. The gunner checks his lay after the gun is loaded, relaying if necessary, and announces READY to the tank commander. All subsequent commands to fire are given by the tank commander; the crew continues to fire rapidly until the specified number of rounds are expended. After the last round is fired, the loader stands by, but does not load. The gunner checks his lay, turns off the gun switch, and waits for a subsequent command. Tank commanders report or signal (as prescribed) ROUNDS COMPLETE to the FCO or inform him of any malfunctions, such as misfires.

Section V. ADJUSTMENT OF TANK INDIRECT FIRE

189. General

Indirect fire is adjusted to bring accurate, massed fire on the target in the shortest possible time, thus obtaining rapid destructive effect before the enemy can take cover or move out of the fire. Fire is adjusted by bracketing the target. Bracketing means to enclose the target between bursts that are over and short for range. This bracket is then reduced until target effect is obtained.
Indirect fire of tanks and artillery (FM 6–135) is adjusted, basically, in the same manner, with the exception that tank indirect fire is characterized by adjustment of a single tank with reference to the observer-target line, while artillery area fire is adjusted by two guns with reference to the observer-target line. The adjustment of indirect fire follows three principles:

a. Bring the burst to the observer-target line.

b. Enclose the target in a range bracket.

c. Split the bracket successively until the target is hit or effect obtained.

190. Sensings, Indirect Fire

The observer mentally senses each burst for range and deviation. Indirect-fire sensings are the same as those for direct fire (pars. 106–108). When more than one gun is fired, the sensing is made from the center of the volley. *Sensings are not announced,* but are used as an aid in making subsequent corrections.

191. Subsequent Fire Requests

A subsequent correction is any change to the firing data made to bring the fire on the target or to a point where it can be more accurately adjusted. Corrections are given in the observer's subsequent fire request in the following sequence to conform with those used for adjusting other types of indirect fire: deviation, range.

a. Deviation Correction. Deviation corrections are made to bring the burst to the OT line. The observer measures the deviation in mils from the burst to the adjusting point (a distinctive terrain feature or some part of the target at or near the center of the area upon which the observer wishes to place fire). Mil deviation is converted to meters (yards) by use of the mil relation (in the same manner as in making a direction correction in the initial fire request). The R factor is the observer-target range expressed to the nearest 100 meters (yards). Deviation corrections are announced to the nearest 10 meters (yards). For example, with an OT range of 3,300 meters (yards), the observer makes a deviation sensing in mils of 30 *right.* He multiplies 30 mils by the R factor of 3.3; the deviation is 99 meters (yards). This is announced as LEFT 100. When time is an essential factor the observer may round off his OT range to the nearest 1,000 meters (yards). To illustrate, in the example shown above, the observer multiplies his deviation sensing of 30 mils by the R factor of 3,300 meters (yards) rounded off to the nearest thousand (3). The deviation is 90 meters (yards) and is announced as LEFT 90. A deviation correction of less than 10 meters (yards) is omitted from the subsequent correction.

b. Range Correction. Range corrections are made in hundreds of meters (yards) until the required correction is less than 100 meters (yards). After the first positive range sensing other than a target sensing, a range change is made by the observer announcing ADD (DROP) (SO MUCH), the amount of the range change being that required to hit the target or establish a bracket. Once established, the bracket is split until the target is inclosed in a 100-meter (yard) bracket. Under certain conditions it may be advisable to split the bracket proportionately, rather than in half. For example, after sending ADD 400, the observer notes that the next round is much closer to the target than was the previous round. In this case, he may send DROP 100 rather than DROP 200. *This procedure should be used only by experienced observers.* A range element is required for each subsequent fire request. When a range change is not necessary, the observer announces REPEAT RANGE. This is necessary because a request for fire does not include the command to fire; therefore, this element indicates the termination of the request unless a change in the type of control is included (par. 192).

192. Type of Control

The type of control is the final element of the subsequent fire request when a change is necessary. Otherwise the type of control is omitted from the subsequent fire request.

a. Fire for Effect. When adjustment of fire is necessary, fire for effect is commenced when splitting a 100-meter (yard) bracket, or when the observer senses *target.* This is announced as ADD (DROP) 50, FIRE FOR EFFECT, or REPEAT RANGE, FIRE FOR EFFECT.

b. Repeat Fire for Effect. To obtain effect on large area targets, or targets that have moved, the observer may request additional fire on the same target. *For example:* RIGHT 50, ADD 50, RE-

PEAT FIRE FOR EFFECT, or REPEAT RANGE, REPEAT FIRE FOR EFFECT.

193. Correcting Firing Data and Subsequent Fire Commands, Indirect Fire

a. Correcting Firing Data. Based on the corrections in firing determined by the observer, the FCO plots the deviation and range corrections, as necessary, and recomputes quadrant elevation and deflection.

Note. The first plotted correction is computed from the target location. Subsequent corrections are computed from the last plotted correction. As an aid in plotting, a pin or a small penciled dot is placed on the target grid for each plot and numbered in consecutive order, starting with the first correction as 1.

(1) *Quadrant elevation.* When a *tabular firing table* is being used, the *range to be fired* is determined by the FCO by measuring from the firing position to the new plotted location and adding this range *algebraically* to the *total range correction* as previously computed.

Note. The total range correction is not recomputed for the range to each new *plot*. Instead, the same *total range correction* is used throughout a target engagement.

Elevation is then determined for this range and combined with angle of site (*which remains the same as initially determined*) for the new quadrant elevation. If a *GFT* is being used, the *new map range* determined by the FCO is indexed under the *hairline* of the indicator and the elevation is read under the *adjusted elevation gage line.* This elevation is combined with angle of site for the new quadrant elevation.

(2) *Deflection.* The FCO measures the perpendicular distance from the *registration point line* to the new plotted location and, using the *new map range,* determines deflection in the same manner as for the initial data, depending on the type of firing table being used.

b. Subsequent Fire Commands. Subsequent fire commands are issued to control firing after the initial fire command has been executed. The fire control officer issues a subsequent fire command to change an element in the initial fire command or a previous subsequent fire command, to cease fire, or to apply the observer's corrections during an adjustment. The sequence of the elements of a subsequent fire command for indirect fire is the same as the initial fire command; however, the number of elements in the command depends on whether the corrections are for adjusting fire or for indicating fire for effect. When the deflection element is unchanged or when other elements are unnecessary, they are omitted, except that range is announced for each command, regardless of change. This is necessary as the gunner must check the quadrant each time before firing to insure an accurate lay.

(1) In the following example, all tanks follow the commands, but only the base tank fires:

Initial fire command	*Subsequent fire request*	*Subsequent fire command*
PLATOON ADJUST,	RIGHT 40	QUADRANT PLUS 74
NUMBER 3	ADD 200	DEFLECTION 2812 RIGHT
HE		AT MY COMMAND____FIRE
QUADRANT PLUS 69		
DEFLECTION 2832 RIGHT		
TROOPS		
AT MY COMMAND____FIRE		

(2) To fire for effect or to make other changes in the initial fire command when the base tank has completed the adjustment, the FCO will make these changes in the following manner:

To fire two platoon volleys for effect:	*Change of fuze and tank to fire:*	*To fire platoon salvo with smoke:*
	NUMBER 4	
PLATOON	3 ROUNDS HE DELAY	PLATOON SALVO LEFT
2 ROUNDS HE	QUADRANT PLUS 71	1 ROUND SMOKE
QUADRANT PLUS 71	DEFLECTION 2815 RIGHT	QUADRANT PLUS 71
AT MY COMMAND____ FIRE	AT MY COMMAND____ FIRE	AT MY COMMAND____ FIRE

Note. Repeating and correcting fire commands for indirect fire is accomplished in the same manner as for direct fire (pars. 102, 103, and 114).

194. Report by Observer

Upon completion of the mission, the observer announces END OF MISSION, and states the results. *For example:* END OF MISSION, ESTIMATED 50 CASUALTIES, REMAINDER DISPERED. The FCO also announces END OF MISSION as the command for all tank guns to be returned to zero deflection. Tubes are elevated for safety purposes. CEASE FIRE is the command to suspend firing pending further orders; at this command, all tanks remain at the last announced quadrant elevation and deflection until a new command is issued.

195. Illustrative Example of Indirect-Fire Mission

Figure 106 illustrates the actions of the observer and fire control officer during an indirect-fire mission of a tank platoon. The platoon has previously registered on the registration point.

Note. Figure 106 illustrates an indirect-fire mission including the actions of the fire control officer when computing subsequent target data using a tabular firing table. When a graphical firing table (GFT) is used, the procedure is as stated in paragraph 175*c*(2).

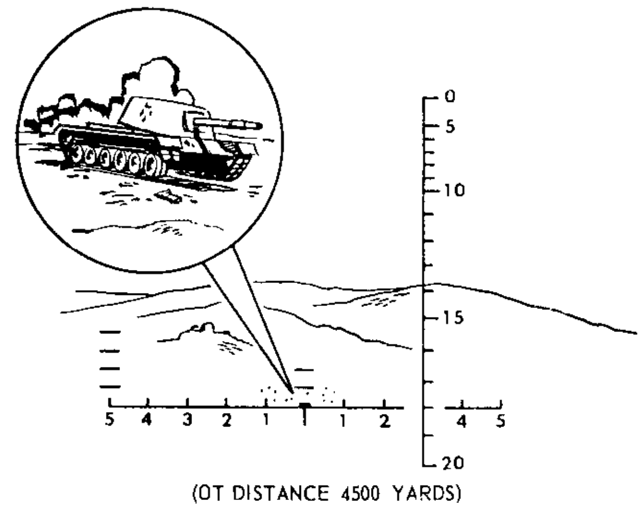
ACTION OR SENSING	FIRE REQUEST, FIRE COMMAND, OR COMPUTATIONS	ILLUSTRATION OF SITUATION
Observer: 1. Acquires a target and selects a disabled tank in the center of the target area as the adjusting point. 2. Locates the target on his map and, using a protractor and map, determines the grid azimuth to the target. 3. Sends an initial fire request.	3. THIS IS ZULU 11. FIRE MISSION: CO-ORDINATES 808898; AZIMUTH 5 760; INFANTRY PLATOON IN THE OPEN; WILL AD-JUST.	

Figure 106. Illustrative example of indirect-fire mission.

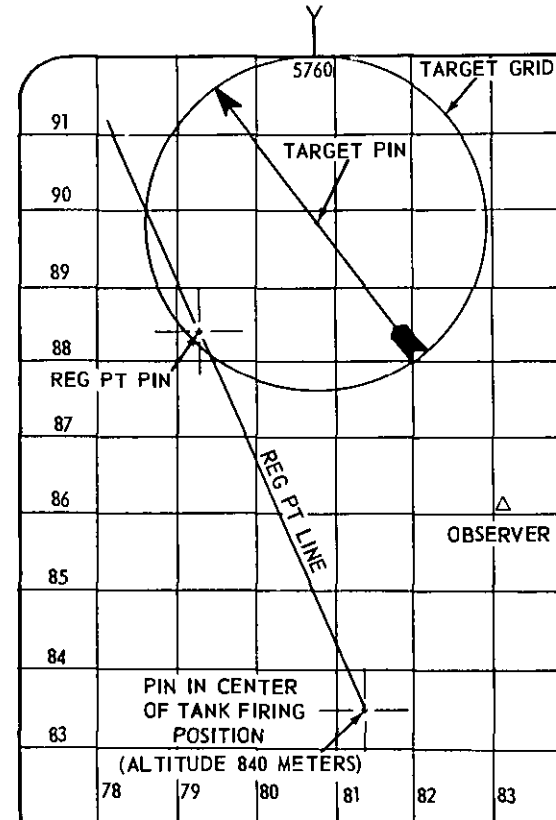
Fire Control Officer (FCO): 1. Records initial fire request and, by coordinates, locates the target on the map. 2. Determines altitude of target from contour lines on map. 3. Pins center of target grid over coordinates of target and plots north index. 4. Turns target grid until observer azimuth is indexed at azimuth index.	2. Target altitude: 770 meters.	

Figure 106—Continued.

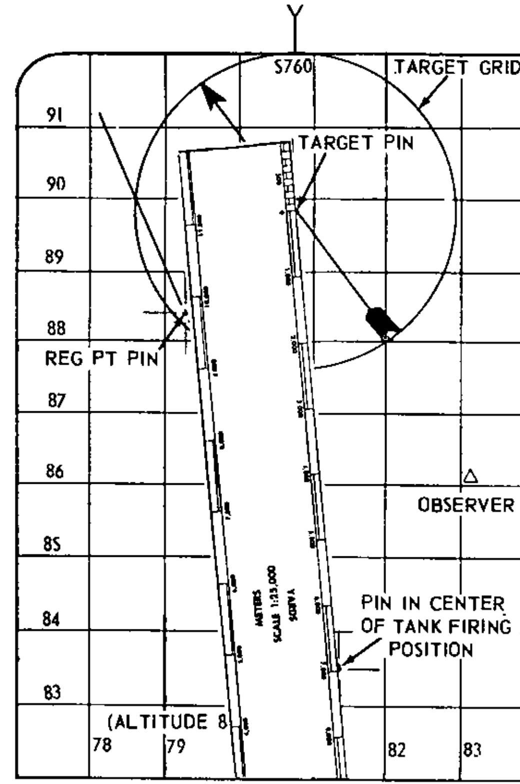
FCO:		
1. Measures the range from the center of the tank firing position to plotted target location and multiplies this figure (in thousands) by the K factor to determine the total range correction. This is then combined with the map range to determine the range to be fired. Note. As the firing tables are in yards and contour interval in meters, measurement is made in both yards and meters.	1. Range to target from guns: 7,000 yards (6,400 meters). K = +50 yards (Assumed) 7x50 = 350 yards	
2. Using a tabular firing table, determines elevation for range for 7,350 yards.	2. Elevation for range to be fired (7,350) = 85.8 mils.	
3. Determines angle of site between firing position and target, using the mil relation.	3. Altitude (guns): 840 meters Altitude (target): 770 meters Difference in altitude: 70 meters	
a. Using true range to target in meters, R factor is 6.4.	a. $\cancel{\alpha} = \frac{W}{R} = \frac{70}{6.4} = -10.9$	
b. As the target is lower than gun, angle of site is minus.	b. Angle of site: -10.9 mils	
4. Combines angle of site with elevation for range to obtain quadrant elevation for this target. As angle of site is minus, he subtracts it from elevation for range.	4. Elevation for range: +85.8 mils Angle of site: -10.9 mils Quadrant elevation: +74.9 or +75 mils	

Figure 106—Continued.

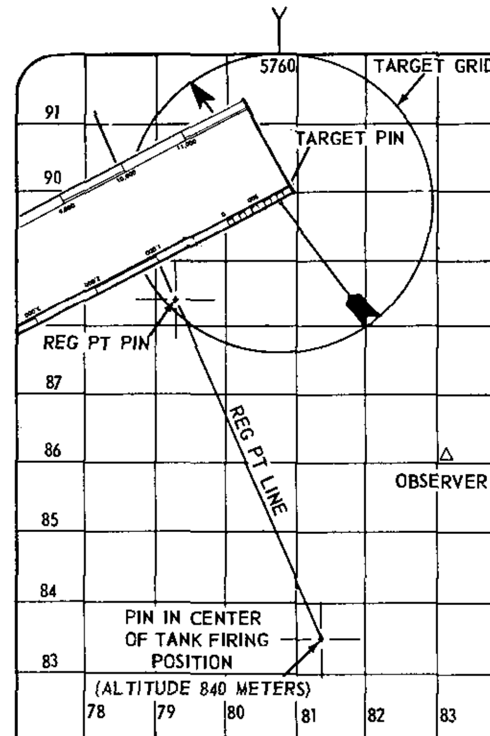
<table>
<tr><th>ACTION OR SENSING</th><th>FIRE REQUEST, FIRE COMMAND, OR COMPUTATIONS</th><th>ILLUSTRATION OF SITUATION</th></tr>
<tr>
<td>FCO:
1. Measures perpendicular distance from registration point line to target location, using range scale.
2. Using the mil relation, computes mil angle between registration point line and gun-target line. R factor is 7.0 (true range 7,000).
3. As the target is right of the registration line, converts the mil angle to a deflection by subtracting from 3,200.</td>
<td>1. Distance (target to registration point line):
1,750 yards.
2. $m = \frac{W}{R} = \frac{1,750}{7} \doteq 250$ mils
3. 3,200
-250
Deflection 2,950 right</td>
<td>
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Figure 106—Continued.

4. Issues initial fire command to tanks to adjust on the target. Notes. 1. All tanks will follow the adjustment but only the base tank fires. 2. Command to fire is given after tank commanders signal READY.	4. PLATOON ADJUST; NUMBER 3; HE; QUADRANT +75; DEFLECTION 2 950 RIGHT; TROOPS; AT MY COMMAND . . . FIRE. Note: If the gunner's quadrant is used, the range element could be given as quadrant +74.9.
5. Informs observer that round is on the way.	5. ON THE WAY.

Figure 106—Continued.

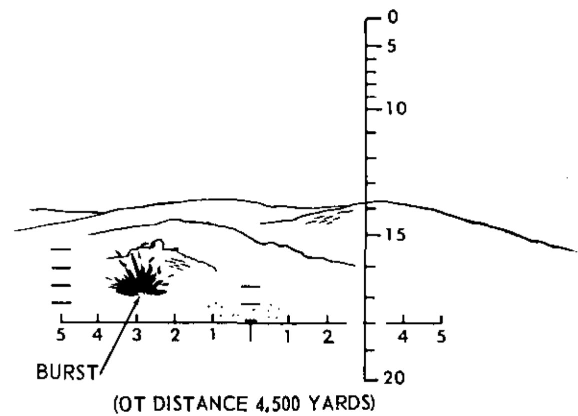
Observer:		
1. Senses, using the binocular, as over and 30 left. Note. This is a mental sensing and is not transmitted to the FCO.		
2. Determines deviation correction using the mil relation. R factor is 4.5.	2. W = R x ~~m~~ W = 4.5 x 30 W = 135	
3. Determines range correction necessary to hit or bracket the adjusting point.		
4. Sends a subsequent fire request, with a deviation correction to the nearest 10 yards and range correction to nearest 100 yards.	4. RIGHT 140; DROP 400.	

Figure 106—Continued.

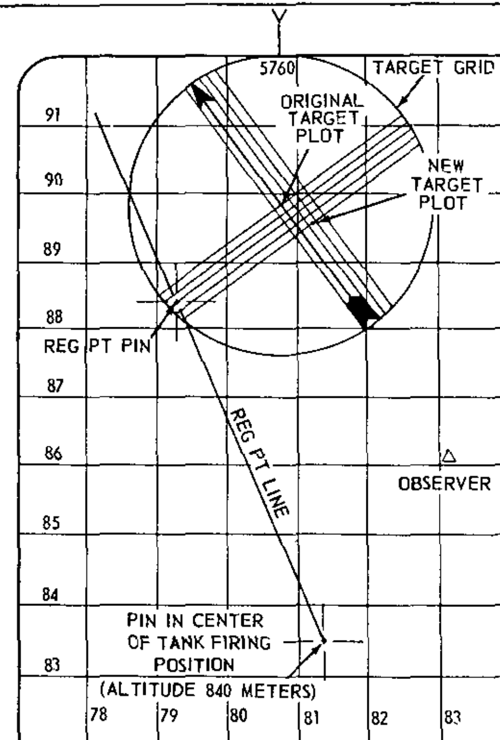
ACTION OR SENSING	FIRE REQUEST, FIRE COMMAND, OR COMPUTATIONS	ILLUSTRATION OF SITUATION
FCO: Plots observer corrections on target grid by moving right and dropping range in relation to index arrow and original target location on target grid, and inserts a pin. Note. Each block on target grid is a 100-yard square at 1:25,000 scale.		

Figure 106—Continued.

FCO:	
1. Measures range to new target plot from center of tank firing position and combines this with the total range correction to determine the new range to be fired.	1. Range to new target plot: *6,750* yards plus 350 for range to be fired.
	2. Elevation for range: to be fired = +81 mils.
2. Using the tabular firing table, determines elevation for range for 7,100 yards.	
3. Combines elevation for range with original angle of site (-10.9).	3. $\begin{array}{r} +81\text{m} \\ \underline{-10.9} \\ \text{QE } +70.1 \text{ mils} \end{array}$
4. Measures perpendicular distance from registration *point line to new target* location.	4. Distance: 2,000 yards.
5. Computes deflection using mil relation. R factor is 6.8 (true range 6,750).	5. $m = \frac{2,000}{6.8} = 294$ mils $\begin{array}{r} 3,200 \\ \underline{-294} \end{array}$ Deflection $\overline{2,906}$ right

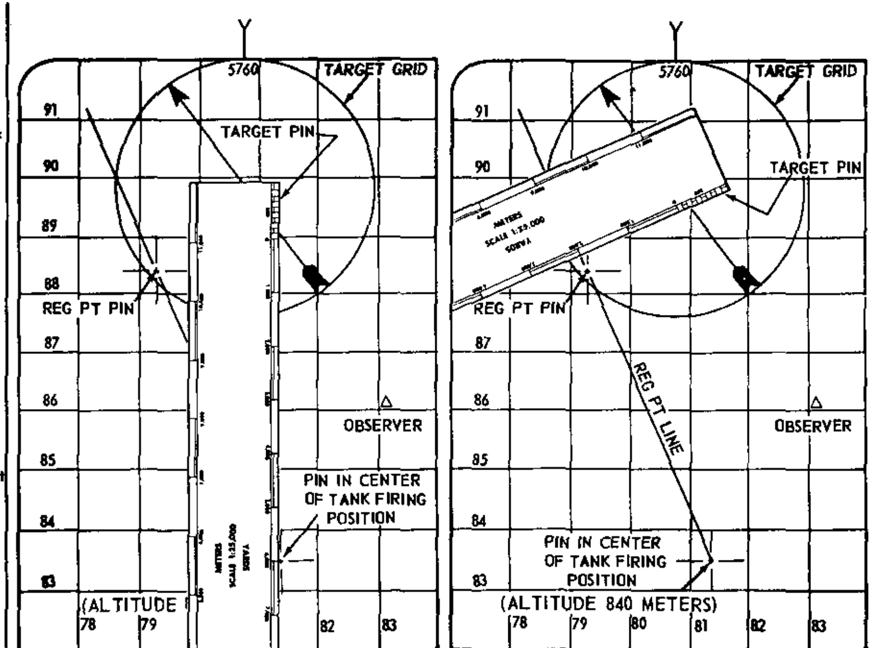


Figure 106—Continued.

FCO:	
1. Issues subsequent fire command to tanks.	1. QUADRANT +70; DEFLECTION 2,906 RIGHT; AT MY COMMAND . . . FIRE.
2. Informs observer that round is on the way.	2. ON THE WAY.

Figure 106—Continued.

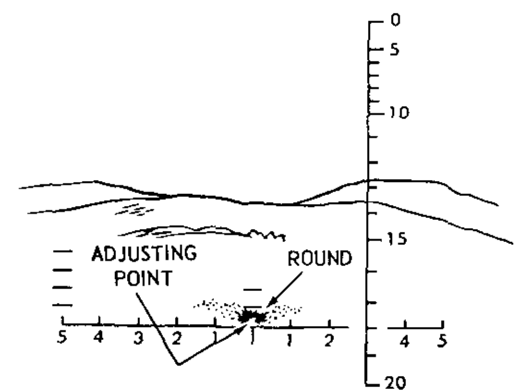
ACTION OR SENSING	FIRE REQUEST, FIRE COMMAND, OR COMPUTATIONS	ILLUSTRATION OF SITUATION
Observer: 1. Using the binocular, senses as TARGET; *therefore,* no range or deviation corrections are necessary. 2. *Sends subsequent fire request.* *Note.* *Had the observer* not sensed TARGET, he would continue to sense and make deviation and range corrections to bring the round to the target. The FCO would plot each correction on the *target grid,* making the correction from the point to which the last data were computed. He would then compute data (quadrant elevation and deflection) to the newly plotted point.	REPEAT RANGE; FIRE *FOR EFFECT.*	

Figure 106—Continued.

FCO: Note. As observer has sensed TARGET, no correction is necessary. 1. Issues command to tanks to fire for effect.	1. PLATOON; 3 ROUNDS HE; QUADRANT +70; AT MY COMMAND . . . FIRE.	1. FCO has decided to fire three platoon volleys on this target. No deflection is included because all tanks have followed the adjustment.
2. Sends report to observer.	2. PLATOON; 3 VOLLEYS; CONCENTRATION AA 151 ON THE WAY.	

Figure 106—Continued.

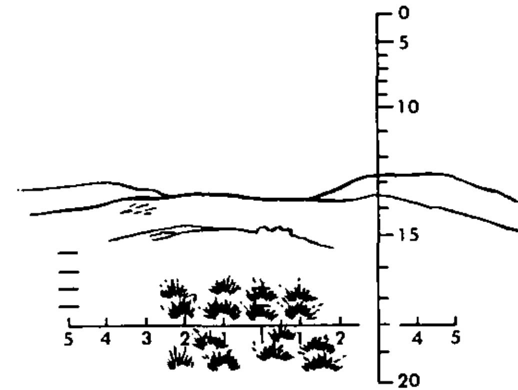
Observer: 1. Senses the fire for effect and may shift it by giving a subsequent fire request or may request additional fire for effect if necessary. 2. When the target is destroyed or neutralized, sends report to FCO.	END OF MISSION. ESTIMATED 10 CASUALTIES. REMAINDER DISPERSED.	
FCO: 1. Completes recorder's log and plots concentration on map. 2. Sends end of mission to guns.	2. END OF MISSION.	2. Upon receiving END OF MISSION, all tanks return to zero deflection and elevate gun tubes.

Figure 106—Continued.

Section VI. INDIRECT FIRE OF TANK PLATOON IN CONJUNCTION WITH ARTILLERY

196. General

a. Tanks employed in an indirect-fire role may be employed in conjunction with artillery units. When a tank unit is employing indirect fire under artillery control, procedures outlined in appendix V, FM 6–40, are applicable. A tank unit assigned such a mission remains under the command of its parent unit; however, its fire is directed and adjusted by artillery personnel.

b. When tank units are employed in conjunction with artillery, there are certain differences from procedures and techniques used when not so employed. These differences are resolved by the armor and artillery commanders. The major considerations are as follows:

(1) Designation of firing positions.
(2) Observation.
(3) Survey.
(4) Fire missions and preparation of firing data.
(5) Communication.

197. Laying Tank Guns From an Orienting Angle

a. An orienting angle is a horizontal, clockwise angle from the direction of fire to the orienting line. An orienting line is a line of known direction (referred deflection) established on the ground in the position area, used as a reference line to lay guns for direction (fig. 107).

b. The artillery unit is responsible for survey so the tank unit can be tied in on the fire direction center charts. Survey personnel will establish the orienting line and the orienting station in the position area designated for the tank unit. Survey personnel will designate, to the tank unit commander or his representative, the location of the orienting station and stakes or points that mark the orienting line. The orienting angle will be furnished to the FCO by the survey party or the fire direction center. The following steps govern laying tank guns parallel from an orienting angle:

(1) Set up the aiming circle over the orienting station or other point on the orienting line where it can be seen from all tanks.

(2) The aiming circle operator sets the orienting angle on the azimuth and micrometer scales, using the upper motion.

(3) Using the lower motion, he sights along the orienting line. This places the 0–3200 line in the direction of fire.

(4) The procedure outlined for laying tank guns parallel on a given grid azimuth (par. 67*b*) will govern laying parallel in the direction of fire.

198. Conduct of Indirect Fire

The artillery fire direction center receives, from an observer, necessary corrections to adjust fire on a target. The FDC then issues fire commands to the FCO of the tank unit, who converts them into initial fire commands, or subsequent fire commands, for the tanks.

199. Fire Commands From Fire Direction Center

Fire commands from the fire direction center (FDC) contain the information necessary for the fire control officer to direct the fire of his unit. These data are given in the same sequence in which they are announced to the tanks. However, two elements of the FDC fire command, range and direction, may require conversion from artillery to tank terms. If the FDC does not have the appropriate firing tables for the tank gun, range is sent as so

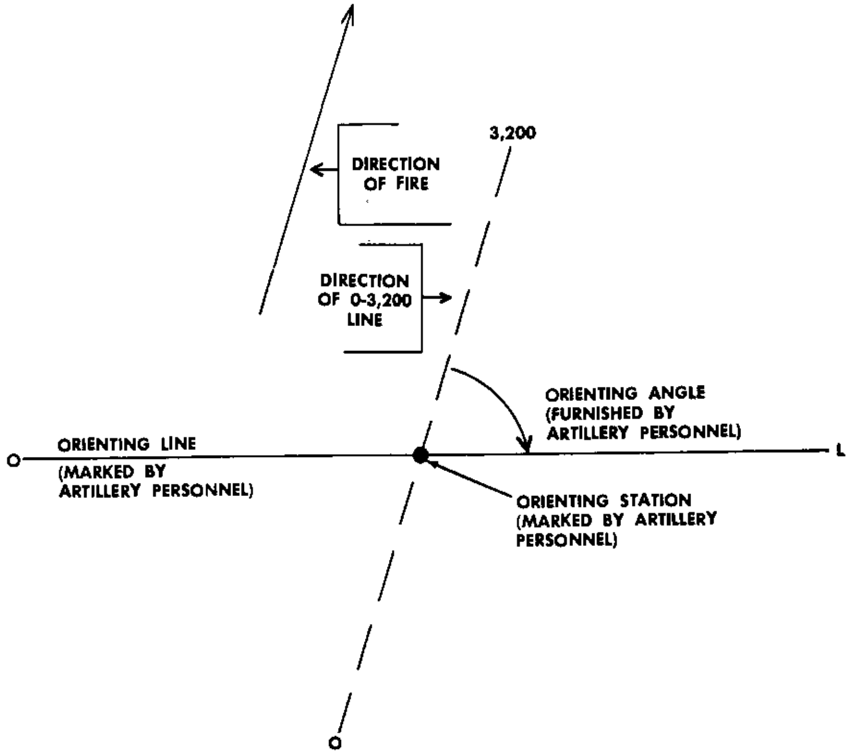


Figure 107. Laying tank guns parallel from an orienting angle.

many meters (yards), plus angle of site (as UP (DOWN) so many mils), e.g., 12,000, UP 10. The FCO must then determine the elevation for range and combine it with the angle of site so it can be announced to the tank crews as a quadrant elevation. If the direction element in the *initial* fire command from the FDC is sent as so many mils *right* of a reference point, this must be converted to a deflection. *For example:* FDC TO FCO: FROM REFERENCE POINT, RIGHT 115; FCO to tank crews: DEFLECTION 3085 RIGHT.

200. Prearranged Data Sheets

When the situation does not allow continuous coordination and communication between the tank and artillery units, the artillery commander may assist the tank unit by the preparation of prearranged data sheets. These data sheets contain the necessary firing data to engage plotted targets. At specified times, the tank unit fires these pearranged missions, using the data furnished by the artillery. This fire may or may not be observed.

Section VII. ADJUSTMENT OF TANK INDIRECT FIRE FROM AIRCRAFT

201. General

Observation and adjustment of indirect fire can be accomplished from aircraft. The aircraft normally are limited to altitudes and locations that allow them to avoid enemy ground fire and enemy fighter aircraft. An air observer normally is employed because it is difficult for a pilot to both navigate and observe. When possible, the air observer and the pilot should be briefed on the ground by the FCO before performing an observation mission.

202. Aerial Observation Procedures

An air observer transmits an initial fire request in the same sequence as does the ground observer, but because the aircraft is constantly moving, the observer-target line method is not applicable. Therefore, sensings are based on a reference line instead of an OT line. The reference line and its direction must be known to the FCO and, if possible, it is established before the flight. When the line is known by the FCO, he determines the azimuth of the line and the target grid is oriented accordingly. Adjustment procedures by the air observer are the same as by the ground observer. There are three reference lines that the air observer may select for use in making his adjustments; the gun-target

(GT) line, a line of known direction, or a convenient line that the observer selects when in flight and describes in sufficient detail so that the FCO can determine its direction. Because the observer moves continuously, his reference line on the ground must be easily identified. In addition, the observer should select a prominent terrain feature or object near the target to facilitate its identification during fire adjustment.

a. Gun-Target Line. The observer may select the GT line as his reference line. If the observer knows the location of the weapons, visualization of the GT line is facilitated. If he does not know the location of the weapons, the observer requests that two rounds be fired at different ranges but at the same deflection setting (ranging rounds). By observing the two bursts, the observer determines the direction of the GT line. Once the observer determines this, he should select terrain features such as a road, stream, or ridgeline, that will assist him in remembering the GT direction.

b. A Line of Known Direction. The observer may select a line formed by a road, railroad, canal, or any series of objects. Prior to flight, the observer selects the line and determines its direction; he informs the appropriate FDC of this line and direction and that he will base his sensings and corrections on it.

c. A Convenient Reference Line. While in flight, the observer may select a reference line that is convenient and easily identifiable. To use this line, the observer must describe it in detail to the FCO so that its direction may be determined.

PART FIVE
TRAINING AND TESTING

CHAPTER 9
INTRODUCTION

203. General

a. Training in tank gunnery is directed toward producing tank crewmen capable of delivering rapid and accurate fire in combat to destroy enemy materiel and personnel. The tank crew must be able to function as a team; crew efficiency depends upon the skill and coordinated action of all its members. Each member of a crew should be trained in the duties of the other members, so that if a crewman becomes a casualty, the tank will still be effective.

b. Commanders should adhere to certain principles of learning and basic teaching techniques and standards to accomplish the training mission efficiently. To insure high standards of proficiency, prescribed tests and exercises are conducted to measure the ability of tank crewmen to apply and use the skills taught during the training cycle.

c. Part five of this manual establishes procedures and standards for training and testing tank crewmen and crews in all aspects of tank gunnery.

204. Sequence of Tank Gunnery Training

a. To develop efficient tank crews, tank gunnery training must be progressive. Crewmen receive training first in individual duties; these are followed by crew exercises.

b. Gunnery skills and crew proficiency are developed through instruction and practice in the following:

(1) *Machineguns.* Characteristics, nomenclature, disassembly, assembly, functioning, malfunctions, immediate action, adjustments, and mounting.

(2) *Tank armament, controls, and equipment.* Familarization with the tank turret, gun and turret controls, vision devices, fire control equipment, and searchlight;

sight adjustment; preventive maintenance services; and destruction of weapons and fire control equipment.

(3) *Tank ammunition.* Identification; characteristics, capabilities, and uses; and handling and stowage.

(4) *Main gun.* Characteristics, nomenclature, disassembly, assembly, functioning, malfunctions, and adjustments; loading and unloading, and removal of a stuck round or separated projectile.

(5) *Range determination.* The mil relation, registration, intersection, maps, and estimation; and practical work on range designation and range determination sites.

(6) *Range finder.* Characteristics, nomenclature, adjustment, and operation, and ranging practice, computing target image coincidence (TIC) settings or internal correction system (ICS) settings, and testing proficiency.

(7) *Conduct of direct fire.* Initial fire command; crew composition and firing duties; use of the binocular; sensings, sensing adjustment, and non-sensing adjustment; firing the main gun at stationary and moving targets; firing tank-mounted machineguns; battlesight; ricochet fire; platoon fire commands; and practical application on trainers or tanks.

(8) *Preparation for firing.* Prepare-to-fire checks, safety precautions, flag signals for range firing; handling, loading, and stowing of ammunition; mounting and dismounting the tank crew; misfire and stoppage procedures; and procedure to clear and secure guns.

(9) *Gun drill and target acquisition.* Crew nonfiring exercises in all phases of target acquisition, conduct of direct fire, and gun drill; also conducted at night in conjunction with range cards ((10) below).

(10) *Range cards and night firing techniques.* Types of range cards, determining data, plotting data, and use of range cards under conditions of good and poor visibility; practical exercises in constructing range cards and applying the data to the fire control equipment; use of the searchlight; and night firing techniques in conjunction with gun drill and target acquisition.

(11) *Tank crewman preliminary gunnery examination.*

(12) *Subcaliber (coaxial machinegun) firing.* Zeroing the coaxial machinegun for subcaliber firing, correct sight picture and accurate laying exercises, primary method of sensing adjustment exercises, alternate method of

sensing adjustment exercises; and moving target exercises.

(13) *Service firing.* Zeroing tank weapons, firing at stationary and moving targets, adjustment of fire, and firing at night with and without illumination; firing from a moving tank with the coaxial machinegun; firing the cupola-mounted or external turret-mounted caliber .50 machinegun at ground and aerial targets; and individual and crew exercises.

Note. Subcaliber and service exercises are fired for qualification, familiarization, and practice.

(14) *Indirect fire from defilade.* (Conducted after crews are proficient in all aspects of direct fire.) Laying tank guns parallel; determining minimum elevation; fire commands and crew duties; and duties of the observer and fire control officer.

205. Methods of Testing Gunnery Training

To evaluate training progress, commanders must have means of determining the relative proficiency and qualification of the tank crews. Even though individuals or crews may complete a training program, until they have been tested, it cannot be definitely established that they have attained the desired proficiency. Training deficiencies noted are corrected by additional instruction.

a. Examination by Observation. Many aspects of gunnery training can be measured only by actual observation of the training or firing. For example, a tank commander who is able to write a correct fire command may not be able to give the command quickly and accurately during a live-firing exercise. Definite objectives must be sought when observing a phase of training.

b. Oral Examination. Normally used as an-on-the-spot check of training. It can be used to test the effectiveness of the instructor and to determine whether the soldier understands the material being presented. Each oral question should have a specific purpose and emphasize one point.

c. Written Examination. This type of test indirectly measures an individual's ability to apply gunnery skills and is best used to determine the knowledge gained over a wide area of subject matter.

d. Performance Test. Proficiency in tank gunnery training can best be determined by the performance test. This type of test can be conducted on numerous phases of gunnery training by having the individual do what he has been taught. A performance test includes and emphasizes such factors as correct procedure, accurate results, and performance within a prescribed time limit. The tank crewman preliminary gunnery examination is an example of a performance test.

CHAPTER 10
NONFIRING EXERCISES

Section I. INTRODUCTION

206. General

Nonfiring exercises are designed to prepare tank crewmen for firing exercises. They are directed toward developing firing skills of the gunner and tank commander and promoting teamwork of the entire crew. A thorough understanding of the operation and functioning of the tank turret and weapons is the first step in gunnery training. This is followed by classroom presentation and familiarization with crew duties and conduct-of-fire procedure for engaging targets. Applicatory nonfiring exercises are conducted before range firing.

Section II. INDIVIDUAL TRAINING TANK GUN CREW

207. General

Success in battle depends upon close coordination within the tank crew. Conduct of fire depends primarily upon the skill and actions of the loader, gunner, and tank commander, who comprise the tank gun crew. The training of these three members is integrated after individual training; however, in all training, each crewman must master his individual duties before the crew can work together as a team.

208. Mechanical Training

As the first step in gunnery training, tank crewmen must learn the weapons, controls, ammunition, and associated equipment for their particular type tank. This is accomplished by classroom work and practical work on the tank or turret trainers. For specific information and procedures, see the technical manual for the tank.

209. Training in Use of Direct-Fire Sights

Use of direct-fire sights must be rapid and accurate when laying on a target and making adjustments. Each individual must know the graduations and uses of the sight reticles. Initial training is conducted in the classroom by the use of charts and slides. This instruction is followed with practical work on a trainer or tank.

a. Conduct-of-Fire Trainer. The conduct-of-fire trainer (fig. 108) is an excellent training aid to teach crewmen the correct sight picture for direct laying and how to make range and deflection changes, set off lead, change lead, and make adjustments when using the primary or secondary sight in conjunction with both sensing and non-sensing methods of adjustment. The conduct-of-fire trainer is used also to teach crew firing duties. Each crew member performs (partially simulated) his assigned firing duties for each problem. Firing problems are conducted as follows:

(1) The tank commander issues an appropriate initial fire command and begins laying the gun for direction.

(2) Upon hearing the ammunition element, the loader simulates loading and announces UP.

(3) The gunner simulates indexing ammunition (and range when necessary) into the fire control system.

(4) On identifying the target, the gunner announces IDENTIFIED and takes over control of the gun and turret.

(5) The gunner takes the correct sight picture, announces ON THE WAY, and simulates firing.

(6) The instructor flashes the light to simulate a burst or tracer for sensing adjustment (or the non-sensing adjustment drill is performed if the instructor has indicated that a type of ammunition is being used that cannot be sensed).

(7) The gunner applies the appropriate method of adjustment, again announces ON THE WAY, and simulates firing.

(8) The problem continues until the tank commander announces CEASE FIRE.

(9) The instructor critiques each problem immediately upon completion.

Note. The instructor should place the light so that it is off the target but within the sight reticle. Before beginning the problem, insure that the reticle can be traversed to the target. If the gunner fails to observe the tracer in sensing adjustment, require the tank commander to announce his range sensing and issue a subsequent fire command.

b. Training on the Tank. Further practical application of direct laying is performed on a tank. The gunner simulates firing and adjusting on various targets using both the primary and secondary sights in conjunction with the sensing and non-sensing methods of adjustment. The instructor or tank commander supervises the gunner by observing through his direct-fire sight, which has been boresighted on the same target as the gunner's. Accuracy is stressed and speed is developed as training progresses.

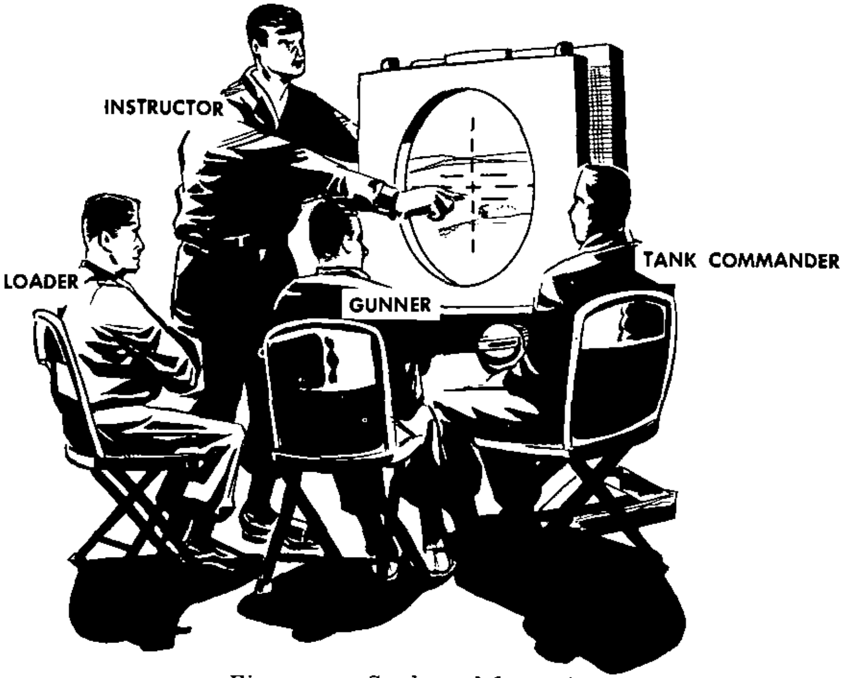


Figure 108. Conduct-of-fire trainer.

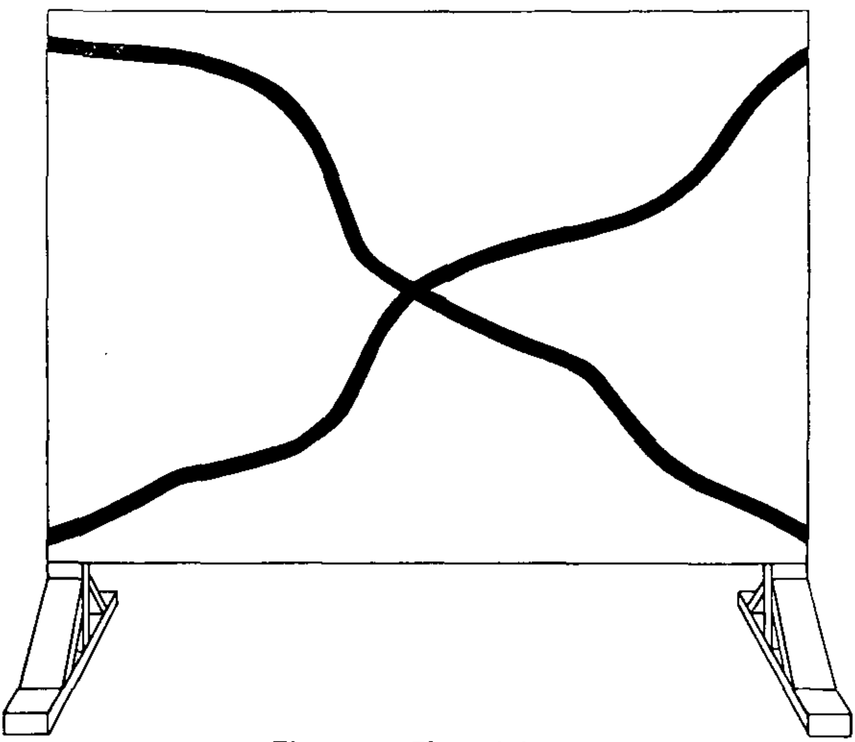


Figure 109. The snakeboard.

c. Aiming Data Charts. The gunner must learn to determine rapidly the correct aiming point to use with a ballistic reticle when firing a type of ammunition other than that for which the reticle is graduated. Aiming data charts are provided in tabular firing tables for this purpose and a computer or ballistic unit can be used to obtain the same information (par. 74*b*). After the gunner lays the gun by using the sight with the ballistic reticle, the instructor checks the sight to determine if the gunner has taken the correct sight picture. This exercise is conducted until the gunner is proficient in determining aiming points using the aiming data chart and the computer or ballistic unit.

210. Manipulatian Exercises

Any exercise that gives the gunner practice in traversing and elevating the gun is called manipulation. These exercises must be practiced by the gunner throughout his gunnery training.

a. The snakeboard (fig. 109) is an effective aid to manipulation training. Lines, approximately 2 inches wide, are drawn on target cloth mounted between two standards or on any vertical surface. The gunner tracks accurately along the lines as rapidly as possible.

b. The next phase of manipulation training requires the gunner to lay rapidly on a series of stationary targets. This is a dry run of the manipulation part of subcaliber firing.

211. Tracking and Leading Exercises

a. Towed-Card Exercise (fig. 110). A line is stretched between two supports at different heights and a card is suspended from the line. The card is pulled along the line by a cord and the gunner tracks the card during its movement. The speed of the moving card is alternately increased and decreased during its run.

b. Combat Tracking. Before firing at a moving target, the gunner performs dry run tracking. A vehicle, or the moving target on a subcaliber or service range, may be used for this purpose. The speed and direction of the target should be varied. The gunner initially tracks with one lead. The gunner simulates firing and adjusting by changing the range and lead as directed by the tank instructor, who observes through his direct-fire sight. The gunner tracks with a smooth continuous motion, maintaining a constant sight picture before, during, and after firing. He does not stop traversing while he simulates firing. When the situation permits, gunners should practice tracking in conjunction with other training.

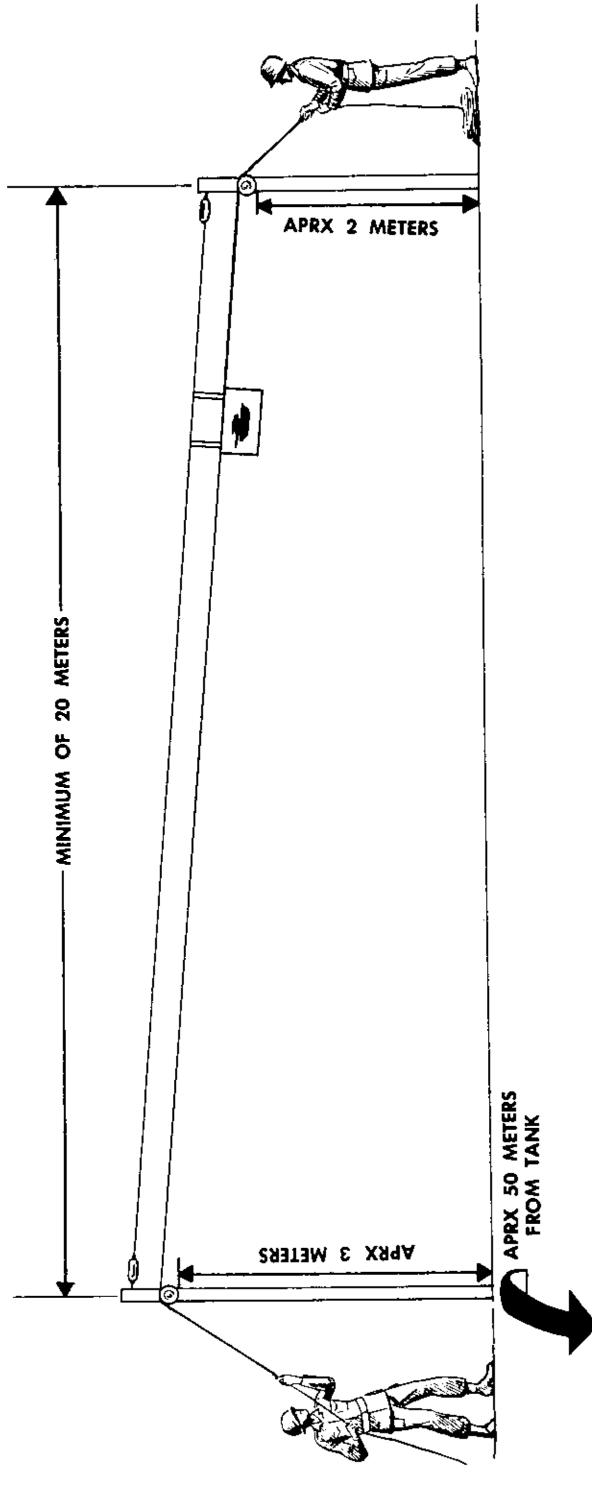


Figure 110. Towed card exercise.

212. Boresighting Exercises

The prescribed steps for boresighting tank weapons should be followed closely and the exercises repeated until the crew is able to make precise adjustments. To check the crew's accuracy, the instructor selects a target with well-defined intersecting horizontal and vertical lines. The crew alines the sight and the weapons (main gun and coaxial machinegun) on the aiming point, locks the boresight knobs, and slips the scales to the prescribed setting. The instructor then traverses the gun off the target, and unlocks and rotates the knobs to disturb the reading. The crew then re-boresights on the same target and readings are compared. This exercise is repeated until accuracy is obtained. This same general procedure is followed in boresighting the cupola-mounted machinegun; however, accuracy is checked as each step is performed.

213. Zeroing Exercises

The zeroing procedure for the main gun can be simulated by placing targets at the zeroing range, with a shot group painted on each target (fig. 115). The gunner simulates firing a shot group, refers his aiming cross to the center of the shot group, and simulates firing a check round. Each time the exercise is completed, the gunner records the azimuth and elevation knob readings. To check the accuracy of the gunner, his results are compared with previously determined zero readings on the same shot group. Any variations in the reading can be directly associated to the gunner's ability to make an accurate lay. This exercise is repeated until accuracy is obtained. The zeroing procedures for the coaxial machinegun and cupola-mounted machinegun are also simulated in the same general manner using target setups as shown in figures 116 and 117. Once crewmen have learned the zeroing procedures in simulated exercises, they are accomplished by actual firing.

214. Training in Use of Auxiliary Fire Control Equipment

a. Each crewman must have practice in obtaining range card data and in simulating firing from these data. This practice can best be obtained by integrating this instruction with target acquisition training (pars. 228–230), although any area with fields of fire up to at least 2,000 meters (yards) can be used. The instructor tests the accuracy of each crewman by first preparing a range card for the area, to be used in checking the crewman's data. This range card should have a minimum of six targets plotted, with approximately half the targets on each side of the reference point. The crewman is then shown the reference point and each target to be plotted and is told the range to each target; with this information, the crewman (gunner) prepares a range card. The card must be accurate and complete with a one-mil tolerance allowed for both quadrant elevation and deflection (the instructor must resolve any question on center of vulnerability of a target). After the crewman has satisfactorily prepared a range card, he should be given practice in applying these data to the auxiliary fire control equipment by simulating firing from range card data. The instructor issues an initial fire command to engage each target. The crewman (gunner) is allowed 20 seconds to correctly apply these data to the auxiliary fire control equipment for each target on tanks with an elevation quadrant and 30 seconds when a gunner's quadrant must be used. Practice in simulating firing the area fire pattern also can be accomplished in conjunction with this instruction. An additional minute should be allowed when this is performed. Accuracy and sequence of application are important. See paragraphs 148 through 152 for obtaining and applying range card data and the area fire pattern.

b. Other appropriate exercises in the use of auxiliary fire control instruments are laying tank guns parallel, determining minimum elevation, and making deflection and range changes for indirect firing.

215. Preparation for Firing

Classroom and practical work are given on prepare-to-fire checks, safety precautions, flag signals for range firing; handling, loading, and stowing ammunition; mounting and dismounting the tank crew; and misfire and stoppage procedures.

Section III. RANGE ESTIMATION TRAINING

216. General

Skill in the estimation of range can be attained only by constant practice. Initial training should be conducted using *range designation* and *range determination* sites. As the crewman acquires proficiency in the estimation of ranges on these sites, training should be integrated or conducted concurrently with other field training. As individual ability increases, more difficult objects, such as camouflaged positions, are introduced.

217. Range Designation Site

a. The *range designation site* (fig. 111) is employed in the initial stage of range estimation training to assist the crewmen in acquiring the mental yardstick necessary to estimate range by eye. The site should, if possible, allow the placement of targets to a range of 3,500 meters (yards). Signs marked 1, 2, 3, and 4 are placed at ranges of 100, 200, 300, and 400 meters (yards) from an observation point. Tanks, tank silhouettes to scale, or 6 x 6-foot panels are placed at 500-meter (-yard) intervals from 500 to 3,500 meters (yards). Finally, the distance to prominent terrain features at greater ranges is determined. From the observation point, the crewman studies all of the marked ranges to get a mental picture of them. He then studies the tank silhouettes farther away, noting how the size tends to decrease as the range increases and the relationship between sizes at specific ranges. If suitable additional terrain exists at the range designation site, practical work may be given by having the crewman estimate ranges to targets in a different direction. While estimating, he refers to the laid out site. After the range to a target has been estimated, the instructor announces the correct range.

b. As units receive tanks with fire control equipment graduated in meters, the unit commander should have a range designation site set up in both meters and yards. In this way, crewmen will have a comparison of these units of measure and can use this as a basis for establishing a mental yardstick in meters.

218. Range Determination Site

a. After the crewman has become accustomed to the measurement of range by use of a mental yardstick, his training should progress to the determination of ranges on a *range determination site*. On this site, he employs techniques of determining range by estimation. Determining range by intersection and use of the mil relation are integrated with this instruction. This site may be established on any terrain having adequate fields of fire. The following steps are necessary to prepare the site:

(1) Determine accurate ranges to prominent objects and terrain features. (Use a rangefinder or the intersection method.)

(2) Measure the height or width of each object or terrain feature in meters (yards).

(3) Determine the mil height or width of each object or terrain feature by means of an aiming circle or any other accurate method.

Note. If several similar objects exist in the target area, the azimuth to each target is measured as an aid to the instructor.

b. A method of instructing on the range determination site is as follows:

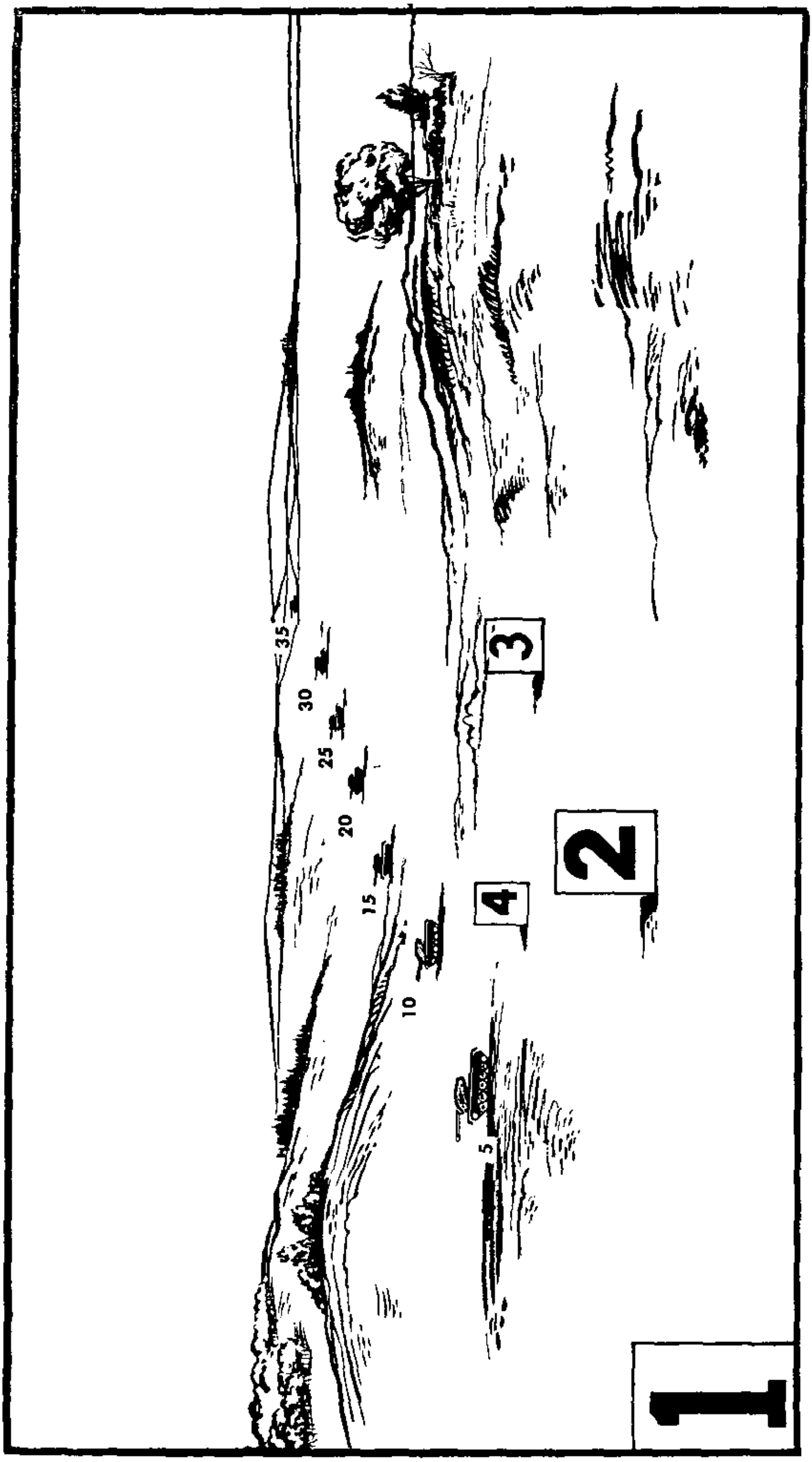


Figure 111. A range designation site.

(1) Have each crewman make the proper diopter and interpupillary settings on his binocular.

(2) Point out targets one at a time, giving sufficient time to estimate and record each range.

(3) Have each crewman measure the mil width or height of each target by use of his binocular and give him the dimension of the portion measured in meters (yards). Have him determine the range by use of the mil relation.

(4) Announce the correct range for each target after estimation and mil relation computations have been made.

(5) Have crewmen, working in groups of 3 or 4, determine the range to several targets using the intersection method. (Tanks or aiming circles for this problem should be prepositioned to check the crewmen's computation.)

219. Advanced Range Determination Training

When individuals have attained reasonable proficiency in determining range on the range determination site, camouflaged targets should be added and used in determining range. Thereafter, training is integrated or concurrent with all field training. Tank crewmen should use every opportunity to practice determining range, first estimating the range and then checking their results against ranges obtained by more accurate means. This includes practice at night with the target area illuminated by tank-mounted searchlights and mortar or artillery illuminating shells.

Section IV. RANGEFINDER TRAINING

220. General

As range determination is the greatest potential cause of error in tank gunnery, the rangefinder can be the key to successful target engagement. A rangefinder combines accuracy with speed in determining range and is used for this task whenever possible. In rangefinder training, the standard is correct range within 5 seconds. This standard is achieved by the simultaneous development of speed and accuracy through frequent ranging practice. Training and testing methods for both coincidence and stereoscopic rangefinders are covered in this section.

221. Training Areas and Equipment

a. Preliminary training in nomenclature, maintenance, adjustment, and operation is conducted in classrooms and motor parks. Ranging practice requires a target-ranging area, accessible to tanks, with targets placed at known ranges from 800 to 3,500 meters (yards). Panel targets are desirable for initial training; however, as proficiency increases, natural terrain and combat-type targets should be used. Targets will be placed in various locations, such as on forward slopes, partially visible on reverse slopes, on the skyline, against contrasting background, and in both thick and sparse vegetation. Some targets should be partially camouflaged.

b. Training aids include graphic charts, training films, slide projectors, depth perception trainers, stereovision trainers, and plastic or wooden reticle models. However, the best training aid is the rangefinder itself.

222. Steps in Rangefinder Training

a. Mechanical Training. Nomenclature, maintenance, and operation of the instrument and its components are taught as preliminary training. Crew maintenance is limited to changing light bulbs and cleaning the instrument, to include the outside lens. All other maintenance is restricted to higher echelon.

b. Adjustment. As inability to use the rangefinder usually can be traced to improper adjustment, operators must master the step-by-step procedure of placing the instrument in operation. For binocular-type rangefinders, the interpupillary distance is one of the most critical adjustments. When a crewman cannot determine an accurate interpupillary adjustment from a binocular, the instructor will use the following method:

(1) Place himself underneath the rangefinder where he can observe the operator's eyes.

(2) With filters off, note two beams of light from the eyepieces shining on or near the operator's eyes.

(3) Instruct the operator to narrow or widen the interpupillary distance, with the adjusting knob, until the beams are centered in the operator's eyes.

c. Ranging Practice. Crewmen practice ranging on targets at varying ranges and locations. Each reading is recorded. This training continues until crewmen are obtaining consistent, but not necessarily correct, rangings on all targets. Crewmen should not range for more than 20 to 30 minutes per hour, or longer than 10 to 15 minutes at any one time. Ranging practice should be conducted in blocks of not more than 4 hours. Crewmen work in pairs; the second man records the range. Initially, the operator is allowed a maximum of 30 seconds for 1 ranging; this time is gradually reduced until he is ranging accurately within 5 seconds. Ranging practice should be conducted also during the hours of darkness with artificial illumination of the target area (tank-mounted searchlights and illuminating shells).

d. Miscellaneous.

(1) The same rangefinder used to determine an individual's target image coincidence (TIC) setting or internal correction system (ICS) setting, should be used for subsequent ranging. If a different rangefinder is used, a new setting is determined. In addition, the TIC setting is not permanent and must be adjusted as necessary (par. 223*b*).

(2) Range spread is the difference between the highest and the lowest readings for one target. (Use a minimum of 20 readings and subtract the lowest from the highest reading.)

(3) Range bias is the average error in ranging. (Determine the average of a minimum of 20 readings and subtract from the known range to the target.)

e. Testing. When the crewman has obtained accuracy, he is tested. The number of rangings required to achieve this degree of proficiency varies with the ability of the individual. Once proficiency in the use of the rangefinder is attained and initial testing is completed, periodic drills and tests will be conducted to insure that proficiency is maintained. Particular attention will be given to checking proficiency in the use of the rangefinder during the periods just prior to tank gunnery firing practice, tank gunnery annual qualification, and Army training tests.

223. Coincidence Rangefinder Training Procedures and Techniques

a. During the first application phase of coincidence rangefinder training, crewmen must be checked individually to insure that they understand and can perform the method of obtaining range with this instrument, i.e., moving target images together until a single, sharp image is obtained (bring into coincidence). After ranging, only those terrain features that are at the same range as the target will be in coincidence; others will be viewed as double images. The operator should habitually range out to a target (starting with a range less than that to the target) and *stop* rotation of the range knob the *instant* coincidence is obtained.

b. Before ranging practice begins, the coincidence reticle must be properly adjusted. The purpose of the coincidence reticle is to serve as a reference point and thereby make it possible to compensate for temperature changes. The reticle must be checked and corrected accordingly (by use of the horizontal and vertical adjustment knobs), several times daily.

c. Initial TIC setting must be established to begin ranging practice. This is accomplished by selecting a target at a range of 1,500 meters, indexing this range on the range scale of the instrument, and alining the target image vertically by use of the vertical adjustment knob and horizontally by use of the horizontal adjustment knob.

Note. Stop rotation of both knobs the *instant* coincidence is obtained. The slip scale of the horizontal adjustment knob is then placed at zero. Then, with this knob, the target is brought into coincidence and the reading on the slip scale recorded. The knob is then arbitrarily moved and the procedure of bringing the target into coincidence is repeated at least 10 times. The readings are added together and divided by the total number. The result is the TIC setting. The horizontal adjustment knob is then rotated until the average reading is indexed on the slip scale.

d. With the target image coincidence setting indexed into the rangefinder, the crewman makes additional practice rangings, gradually building proficiency.

e. When a crewman is familiar with the rangefinder controls and adjustments, knows how to place it in operation, and has made a minimum of 100 rangings, he is ready to be tested.

224. Stereoscopic Rangefinder Training Procedures and Techniques

a. During the first application phase of stereoscopic rangefinder training, crewmen must be checked individually to insure they understand and can perform the method of obtaining range with this instrument, i.e., moving the ranging reticle in depth until the lower vertical bar appears at the same range as the target. The ranging reticle is positioned just above, or to one side, of the target when ranging, depending on the desires of the operator.

b. For initial ranging practice, the internal correction system (ICS) knob is placed in the center of its adjustment (25) for an arbitrary setting. When the operator is ranging consistently with a spread of 200 yards or less, his initial ICS setting should be determined. The ICS setting is determined mechanically and will assist the crewman in ranging more accurately. This setting will decrease the average ranging error, but will not necessarily give him true ranges at this early stage. To determine his initial ICS setting, the operator is assigned a target at a known range as near 1,500 yards as possible. He then performs the following:

(1) Indexes the known range on the range scale.
(2) Uses the ICS knob to range on the target.
(3) Records the ICS scale reading.
(4) Repeats the procedure for at least 10 readings.
(5) Determines the average reading, which is his initial ICS setting for that rangefinder.

c. With the initial ICS setting indexed into the rangefinder, the crewman makes additional practice rangings, gradually building up proficiency. When his spread is 100 yards or less, he is ready to establish his corrected ICS setting. If he is consistent, the operator can determine his setting more accurately by use of an ICS correction chart (fig. 112) than by mechanical means. This is done in the following manner:

(1) A representative block of 20 rangings made on a 1,500-yard target is obtained from a study of the crewman's ranging sheets.

(2) Range bias (average error) for the 1,500-yard target is determined and the corresponding correction read from an ICS correction chart.

(3) If the operator's average range was short of the target, he has a minus bias and must add ICS units to his setting.

(4) If the operator's average range was beyond the target, he has a plus bias and must subtract ICS units from his setting.

d. The corrected ICS setting is now checked by additional ranging at 1,500 yards. If necessary, this corrected setting is further refined by making small corrections until the operator has determined his setting for 1,500 yards as closely as possible. If a chart is not available, refinements of settings can be made mechanically.

e. The best range for determining ICS settings is 1,500 yards; however, one setting does not hold true at all ranges. For example, if a crewman has refined his setting to the point where he is making correct rangings at 1,500 yards, he will most likely be overranging by about 50 yards on 2,000-yard targets. As it is not practical to establish a setting for all ranges, a final ICS setting is established by subtracting 4 ICS units from the corrected setting. This revision will affect accuracy slightly at 1,500 yards, but will greatly improve it at 2,000 yards.

f. When a crewman has obtained his final ICS setting, he is ready to be tested.

225. Testing Rangefinder Operators

The testing site should be in a different location from the area for practice ranging; however, if this is not practicable, new targets may be erected in the practice ranging area. A minimum of six 6 x 6-foot panels are placed at varying known ranges from 1,000 to 3,500 meters (yards). Using the crewman's final TIC

TABLE

ICS CORRECTION FOR 1,500 YARDS
STEREO RANGE FINDER, M13

(PLUS OR MINUS)	ICS UNITS
10	2
20	3
30	5
40	6
50	8
60	9
70	11
80	12
90	14
100	15
110	17
120	18
130	20
140	21
150	23

Figure 112. ICS correction chart.

or ICS setting, the operator makes 20 rangings on each of the targets. Each ranging starts from an indexed range of 500 meters (yards) in such a sequence that no two rangings on any one target are consecutive. The range scale on the rangefinder is covered so that the operator cannot read it and the operator is not informed of the range to any target. The examiner notes and records each reading from the computer, reindexing 500 meters (yards) on the rangefinder for the next ranging. At the completion of the test, the readings for all targets are computed. The tested crewman is informed of his spread, bias, and classification after computations are made. Operator proficiency is determined in the following manner:

a. The average range reading for each target is computed by adding all readings for that target and dividing by 20.

b. Range bias for each target is obtained by determining the difference between the average range reading and the known range for that target.

c. Range spread for each target is obtained by subtracting the smallest reading from the largest.

d. Each crewman is classified as a *qualified* or *unqualified* rangefinder operator. The standard for qualification is a range bias no greater than plus or minus 30 meters (yards) on a coincidence rangefinder and plus or minus 50 yards on a stereoscopic rangefinder and a range spread no greater than 100 meters (yards) for each type rangefinder at each target. If this standard is not achieved, the individual is unqualified.

226. Improving Proficiency in Ranging

a. Spread. When an operator has a spread of more than 100 meters (yards), he is still making inconsistent rangings. The only way to develop consistency, or reduce spread, is through more ranging practice; however, additional practice is not a sure cure as all crewmen eventually reach the point of their maximum ability. Beyond this point, more ranging may not produce improvement, but it will enable the operator to maintain the proficiency that he has gained.

b. Bias. When an operator has a bias exceeding that for qualification, but a good spread, his lack of accuracy is probably due to an improper TIC or ICS setting. To verify this, his rangings should be checked for at least two successive days. If he continues to range with the same bias, his TIC or ICS setting should be corrected accordingly. However, if he is short one day and over the next, no correction is made.

Note. With a coincidence-type rangefinder, insure that the operator establishes his TIC setting and determines range by stopping rotation of the appropriate control the *instant* coincidence is obtained.

c. Lack of Stereovision. A few persons do not have stereovision in the degree necessary to obtain acceptable results with a stereoscopic rangefinder, regardless of the amount of training and practice. When this condition exists (determined by medical examination), the individual can be taught to determine ranges rapidly and with greater accuracy than by estimation, using intersection with the rangefinder. This method is less accurate and slower than normal stereoscopic operation and should, therefore, be taught to and employed by, only individuals without stereovision. The method is as follows (use one eye at a time):

(1) Using the gun controls, lay one edge (left or right) of the lower vertical bar of the fixed stereopattern in one eyepiece on a definite point on the target..

(2) Using the ranging knob, move the corresponding edge of the lower vertical bar of the movable stereopattern in the other eyepiece to the same point on the target. This completes ranging.

Note. When the ranging reticle (fused image of both stereopatterns) is viewed stereoscopically, it will appear to move in depth. When viewed separately, one of the two stereopatterns moves laterally. When lack of stereovision is due to one eye being much weaker than the other, the stronger eye should be used to lay both stereopatterns in the intersection method.

227. Retesting Rangefinder Operators

Personnel who achieved a good spread on their initial test may be retested after their TIC or ICS setting is corrected. Those who had excessive spread should be retested after additional practice.

Section V. TRAINING IN TARGET ACQUISITION

228. General

a. Combat realism is emphasized in tank weapons firing by use of targets that are as realistic as possible, e.g., tank hulls and other salvaged vehicles. Fulfillment of this requirement depends on the availability of this type of target. Where there are an insufficient number available, artificial or panel targets must be used. Firing at artificial or panel targets gives the crewmen a false impression of what to expect concerning location and identification of targets in combat. Training in target acquisition is employed to give more realistic training in this respect.

b. Target acquisition is primarily the responsibility of the tank commander; however, he is assisted in this task by all other crew members (par. 90). To assist the tank commander and to insure that enemy positions, weapons, and vehicles are quickly spotted, the other members of the crew are assigned sectors of observation. Infantrymen also frequently assist in location of targets (pars. 164 and 165). Once a target has been located and identified and the decision has been made to take it under fire, action is initiated to engage it with speed and accuracy.

c. Target acquisition exercises can be of various types, but the purpose of all types is to give the crew practice in rapidly locating and identifying combat targets. This exercise is most beneficial when conducted under tactical conditions with an Aggressor force. The area used for rangefinder training can usually be adapted to this type of training.

d. Target acquisition incorporates training in crew drill, conduct of fire, and range cards (when desired).

229. Course Layout for Target Acquisition Training

Tanks are placed in firing positions and static and live targets are positioned (fig. 113) out to a maximum of 3,500 meters (yards). These targets should be positioned so that they must move or "fire" before they become readily visible to the tank crews. Such things as tanks, tank hulls, trucks, personnel carriers, machineguns, bunkers, dismounted infantry, etc., can be used for targets. Demolitions, simulators, and blank ammunition are used to simulate enemy fire.

230. Conduct of Target Acquisition Exercise

a. The members of the tank crew observe in their assigned sectors. Target activity is controlled by the instructor using radio communication. Crew members report targets as they are located. This report is accomplished by announcing the type target, followed by the approximate range and direction (par. 90). When the tank commander decides to engage a target, he issues an initial fire command. If two or more targets are encountered at one time, the tank commander must select the most dangerous target for engagement; however, the caliber .50 machinegun can be used also to engage a target when the main gun is being used.

b. To measure crew proficiency in this exercise, the following factors are considered:

(1) Time elapsed before a target is located after it has "fired" or moved.

(2) Identification of the target.

(3) Ranging time (when applicable).

(4) Accuracy of determined range.

(5) Speed and accuracy of lay.

(6) Selection of the most dangerous target.

(7) Selection of the correct ammunition and weapon.

(8) Execution of crew firing duties.

c. After becoming proficient in locating and identifying combat targets from a stationary position, the next phase is to accomplish this task from a moving tank.

d. Target acquisition training is continued under conditions of darkness. Target activity is controlled as in *a* above. As targets are located, the crew simulates firing at some of the targets using range card data, and at others using illumination provided by tank-mounted searchlights or illuminating shells (mortar or artillery).

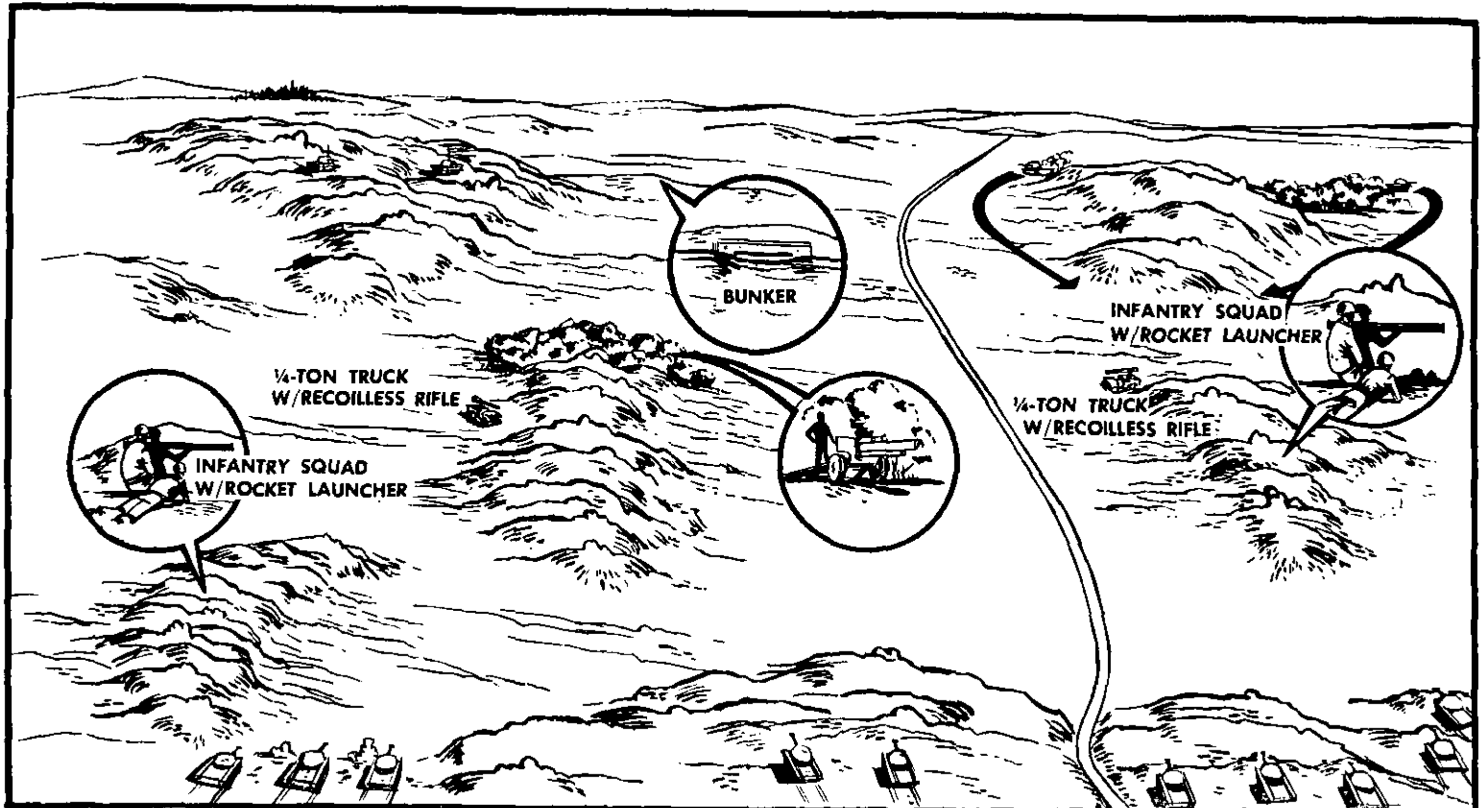


Figure 113. Target acquisition site.

CHAPTER 11
FIRING EXERCISES

Section I. INTRODUCTION

231. General

The tank is an effective fighting machine only when the crew is capable of delivering fire with speed and accuracy. Firing exercises are designed to provide the tank crew with training in the destruction of targets under varied conditions so they will attain this proficiency. These exercises are the culmination of gunnery training and are the most important type of gunnery training. Range firing exercises afford opportunities to apply by individual and collective efforts, subject matter that was previously learned in the form of theoretical and non-firing exercises. Tank firing should not be limited to annual qualification firing. To attain and maintain the proficiency of all tank crews in gunnery, unit commanders will also schedule periods of practice firing and familiarization firing when necessary.

232. Types of Firing Exercises

a. Qualification firing (pars. 234–265).

b. Familiarization firing (pars. 266–268).

c. Practice firing (pars. 269 and 270).

233. Firing Skills

Individual and crew firing skills are developed by firing subcaliber and service exercises in a logical sequence.

a. Subcaliber Firing. The purpose of subcaliber firing is to develop speed and accuracy when engaging targets and give crewmen practice in using the direct fire sights, turret controls, and fire control equipment without subjecting them to the blast and recoil of the main gun and without expending main gun ammunition.

b. Service Firing. The purpose of service firing is to provide practice in firing the main gun at various targets and ranges and to develop skill, speed, and accuracy in applying gunnery techniques. At the same time, personnel are mentally conditioned to the blast and recoil of the main gun. In addition, these exercises provide practice in gun and turret preventive maintenance services, handling and stowage of ammunition, and safety precautions connected with tank firing.

c. *Crew Field Firing and Crew Proficiency Exercises.* The purpose of these exercises is to develop speed and coordinated action by all members of the crew. The crew is required to move the tank over unimproved terrain and rapidly engage various type targets at varied ranges with the proper weapon and ammunition. These combat-type exercises provide the crew with the opportunity to achieve the high standards of training and efficiency necessary in combat.

d. *Night Firing.* The purpose of night firing is to give the tank crew practice in rapidly engaging and destroying targets that have been illuminated by artificial means and targets that cannot be seen. Furthermore, night firing exercises familiarize the crew with the various methods of illumination and instill confidence in crew members by showing the effectiveness of tank weapons under these conditions.

Section II. TANK GUNNERY QUALIFICATION COURSE

234. General

Paragraphs 234 through 265 contain the prescribed tank gunnery qualification course and gunnery qualification standards. All members of a tank crew (tank commander, gunner, loader, and driver) and other personnel as outlined in AR 370–5 will fire the tank gunnery qualification course for qualification at least once annually.

a. The purpose of the tank gunnery qualification course is to provide a means of determining the proficiency of the tank crewman and the tank crew in gunnery. Tables I through V test each crewman as a gunner and tables VI through VIIIB test the tank crew as a crew. All the tables serve as an adjunct to training in the proper care and use of the weapons and their accessories. The complete tank gunnery qualification course is organized and conducted as follows:

(1) *Tank crewman preliminary gunnery examination.*

(2) *Tank crewman gunnery qualification—subcaliber firing.*
Table I—first-round-hit exercises
Table II—sensing adjustment exercises
Table III—moving target exercises

(3) *Tank crewman gunnery qualification—service firing.*
Table IV—stationary target exercises
Table V—moving target exercises

(4) *Tank crew gunnery qualification firing.*
Table IV—crew machinegun exercises (day)
Table VIIA—crew field firing exercises (day)
Table VIIB—crew field firing exercises (night)
Table VIIIA—crew proficiency exercises (day)
Table VIIIB—crew proficiency exercises (night)

b. Each tank crewman must satisfactorily complete the tank crewman preliminary gunnery examination before firing the subcaliber exercises. The crewman fires the subcaliber exercises once for practice and once for record. He must qualify on the subcaliber exercises before firing the service exercises. The crewman fires the service exercises for record only. He must satisfactorily complete the service exercises to qualify for the position of tank commander or gunner of a tank crew participating in the tank crew gunnery qualification exercises. Other members of the tank crew must have fired the subcaliber exercises (and service exercises, if qualified) before participating as a member of a tank crew, other than tank commander or gunner, in the tank crew gunnery qualification exercises.

Note. An exception may be made to this requirement if crew members are assigned to a unit after the crewman's tables have been conducted, but before the crew tables are fired. In such cases, these persons may participate as crew members (other than tank commander or gunner) after satisfactorily completing the preliminary gunnery examination.

c. Classification of tank crewmen and tank crews is based on the score attained on the appropriate tables. Both crewman and crew are classified as expert, sharpshooter, marksman, or unqualified.

(1) There are two separate qualification categories for a crewman; one for subcaliber firing and one for service firing, but a qualification badge is awarded for only one category at a time. These scores are not combined and a crewman who fires the service tables is not awarded a badge for subcaliber firing; if such a badge has been previously awarded, it is automatically revoked. The indicated minimum satisfactory score must be attained on each table for a classification of marksman or higher to be awarded. These classifications are the basis for awarding arms qualification badges in conjunction with the following stipulations:

(*a*) In active Army units, both subcaliber and service tables must be fired annually unless a waiver of the service firing requirement is obtained from the appropriate theater commander. Such waivers are granted only when a unit does not have access to range facilities where service firing can be conducted.

(*b*) In Army reserve component units, the type and amount of firing is based on annual training requirements; therefore, awards based on subcaliber firing only are authorized in years when service firing is not conducted.

(*c*)

Individual classification—subcaliber firing	*Score*
Total possible	300
Expert	280
Sharpshotter	240
Marksman	210
Unqualified	Below 210

Note. The second firing of each table is scored for record.

(*d*)

Individual classification—service firing	*Score*
Total possible	200
Expert	185
Sharpshooter	160
Marksman	140
Unqualified	Below 140

(2) Classification of tank crews is based on the combined scores of tables VIIIA and VIIIB (par. 260). The indicated minimum satisfactory score must be attained on each table in order for a classification of marksman or better to be awarded. Arms qualification badges are not awarded for crew classifications; however, notations indicating crew position and crew classification will be entered on individual qualification records.

Crew Classification	*Score*
Total possible	2,000
Expert	1,800
Sharpshooter	1,500
Marksman	1,300
Unqualified	Below 1,300

235. Ammunition Required for Qualification Firing

a. The following chart lists the ammunition required for one crewman to fire the tank crewman's gunnery qualification tables:

Table	Coaxial MG tracer, MLB	Main gun	
		HE or HEP	AP–T or TP–T
I[a] [d] [e]	20		
II[b] [d] [e]	25		
III[c] [d] [e]	20		
IV[f]	----------	2	8
V[f]	----------	----------	10
Total practice	65	0	0
Total record	65	2	18

[a] Includes 5 rounds for crewman who needs extra ammunition for zeroing, and to compensate for multiple-round bursts due to malfunctions of the single-shot device.

[b] Includes 5 rounds to compensate for multiple-round bursts and for lost rounds.

[c] Includes 5 rounds for examiner to zero, and to compensate for multiple-round bursts and for lost rounds.

[d] The most recently packed standard coaxial machinegun tracer ammunition available will be used.

[e] Frangible ammunition may be substituted for tracer when only limited range facilities are available.

[f] Includes 2 rounds AP–T or TP–T for crewman to verify zero.

b. Five rounds of main gun ammunition are required to establish the zero of each gun to be used for tables IV through VIIIB, for which a zero has not previously been established. Seventy-five rounds of coaxial machinegun ammunition and 10 rounds of caliber .50 ammunition are required to zero the machineguns of each tank for service firing.

c. The following chart lists the ammunition required for one crew to fire the tank crew gunnery qualification tables:

Table	Coaxial MG, 4–1, MLB [e]	Cal .50, 4–1, MLB [e]	Main gun			Illum shell	Flare [g]
			HE or HEP	AP–T or TP–T	WP [f]		
VI[a]	250	50					
VI[b]	250	50					
VIIA[a]	100	100	2	4			
VIIB[a] [c]	150	50	2	4	----------	3	
VIIA[b]	100	100	2	4			
VIIB[b] [c]	150	50	2	4	----------	3	
VIIIA[d]	200	100	2	6	2		
VIIIB[c]	200	100	4	4	----------	3	1
Crew total	1,400	600	14	26	2	9	1

[a] First firing of table.

[b] Second firing of table.

[c] Twelve additional illuminating shells (mortar or artillery) are required daily for registration.

[d] Includes 2 rounds of AP–T or TP–T for crew to verify and refine the established zero.

[e] Four nontracer to one tracer round.

[f] HE or HEP may be substituted.

[g] Rifle or hand-held.

236. Rules for Record Firing

a. General. Prior to record firing, examining personnel must be thoroughly familiar with their duties, including correct firing and scoring procedures. If a malfunction occurs, the examiner notes the time and determines the nature of the malfunction. After the malfunction has been corrected, the crewman or crew is permitted to complete the exercise. If the malfunction was not due to negligence of the gunner or crew being tested, the time required to correct the malfunction is *not* counted against the time allowed for that phase of the test. If the malfunction results from the crewman's or crew's failure to perform required duties, it is considered negligence, and no time credit will be allowed. Only rounds that can be sensed and the sensing methods of adjustment are used in qualification firing. All tank weapons to be used in firing tables IV through VIIIB will have a zero established.

Note. On a tank with an infinity sight that has no scales on the boresight knobs, care must be taken not to move these knobs once the coaxial machinegun has been zeroed.

b. Tank Crewman Gunnery Qualification Tables. Examiners may be either commissioned or noncommissioned officers. Only the crewman being tested, examining personnel, and the necessary personnel of the assigned crew of which the crewman being tested is a member, will be in the tank during record firing. The examiner will take the tank commander's station. Before firing, the crewman is required to check the condition of the weapons, controls, sights, and ammunition. He is permitted a maximum of 30 minutes to make these checks; however, the time taken to correct any deficiencies discovered does not count against the crewman's time. During firing, the crewman, as gunner and without the benefit of coaching or assistance, performs all operations required by the test.

c. Tank Crew Gunnery Qualification Tables. Examiners may be either commissioned or noncommissioned officers. Only the examiner and the members of the crew in their assigned positions will be in the tank during firing. The examiner will be outside the tank where he can best control and score the tank crew and will use the intercommunication system for monitoring and control. The crew should use its assigned tank, if possible; but regardless of the tank used, the crew will be held responsible that the tank is fully operational and mechanically prepared to fire each exercise by performing the proper checks and reporting any deficiencies. The crew will be permitted a maximum of 30 minutes to make these checks; however, the time taken to correct any deficiencies discovered does not count against the crew's time.

During firing, the crew will perform all the operations required by the test without benefit of coaching or assistance.

Section III. TANK CREWMAN PRELIMINARY GUNNERY EXAMINATION

237. General

The tank crewman preliminary gunnery examination is designed to assist the commander in determining whether his tank crewmen are sufficiently trained to perform the functions connected with firing the qualification tables. Accordingly, each member of the tank crew is required to perform each test satisfactorily within the time allotted before he is permitted to fire the subcaliber tables or participate as a member of a crew firing the tank crew gunnery qualification tables. Failure of any part of a test means that the crewman fails the examination and, after any necessary training, must be re-examined on the tests he has failed. The examination is conducted under the direction of an officer by examiners who may be officers or noncommissioned officers. Results are recorded on an examination record (fig. 114).

238. Test on Field Disassembly and Assembly of Breech Mechanism

a. Procedure. The breech cover is removed, the gun travel lock is disengaged, and all devices necessary to remove the breechblock are installed, with the exception of the breechblock removing tool. The examiner assists in the removal of the operating shaft, when applicable, and in elevating and depressing the breech as directed by the crewman being tested. The examiner commands DISASSEMBLE BREECH MECHANISM (BLOCK). The crewman is required to field disassemble the breech mechanism and breechblock of the 90-mm gun within 5 minutes, a gun of lesser caliber within 4 minutes, or a gun of greater caliber within 6 minutes, using the prescribed method. The examiner then commands ASSEMBLE BREECH MECHANISM (BLOCK). The crewman is required to assemble the breechblock and breech mechanism within the same time limits prescribed for disassembly. The closing spring is *not* removed in this test.

Note. On the 105-mm gun, only the breechblock is disassembled and assembled.

b. Examiner's Guide.

(1) Examiner: DISASSEMBLE BREECH MECHANISM (BLOCK). (Starts time.)

(2) Crewman: Disassembles breech and announces COMPLETE.

UNIT ________________ NAME ________________

DATE ________________ GRADE ________________ SN ________________

TANK CREWMAN PRELIMINARY GUNNERY EXAMINATION RECORD

TEST No.	TITLE	SAT	UNSAT	REMARKS**	EXAMINER'S INITIALS
1	Field disassembly and assembly of breech mechanism.				
2	Putting turret in power operation.				
3	Use of replenisher indicator tape.				
4	Identification and use of ammunition.				
*5	Checking and adjusting firing mechanisms.				
6	Boresighting and zeroing the main gun.				
7	Boresighting and zeroing the coaxial machinegun.				
*8	Boresighting and zeroing the cupola-mounted machinegun.				
9	Direct laying and sensing adjustment.				
10	Non-sensing method of adjustment.				
11	Preparing and firing from a range card.				
*12	Adjusting head space on caliber .30 machinegun.				
*13	Adjusting head space and timing and mounting on caliber .50 machinegun.				
14	Misfire procedure.				
15	Safety and control measures.				

*Does not apply to all type tanks or applies only in part.

**P—Procedure incorrect A—Accuracy not attained
T—Time limit exceeded X—Requires much more training

COMMENT: ________________

QUALIFIED YES [ ] NO [ ]

____
OFFICER IN CHARGE

Figure 114. Tank crewman preliminary gunnery examination record.

(3) Examiner: Stops time.

(4) Time: 4, 5, or 6 minutes, depending on the caliber of the gun (*a* above).

(5) Examiner: ASSEMBLE BREECH MECHANISM (BLOCK). (Starts time.)

(6) Crewman: Assembles breech and announces COMPLETE.

(7) Examiner: Stops time.

(8) Time: 4, 5, or 6 minutes, depending on the caliber of the gun (*a* above).

Note. Disregard minor errors in sequence.

239. Test on Putting Turret in Power Operation

a. Procedure. The crewman is required to put the turret in power operation within 2 minutes, performing all steps in the prescribed sequence.

b. Examiner's Guide.

(1) Examiner: PUT TURRET IN POWER. (Starts time.)

(2) Crewman: Alerts crew (announces POWER).
Checks oil.
Unlocks turret.
Turns on power.
Elevates and traverses.
(Again checks oil when applicable.)
Announces COMPLETE.

(3) Examiner: Stops time.

(4) Time: 2 minutes.

Note. Sequence is important.

240. Test on Use of Replenisher Indicator Tape

a. Procedure. The examiner hands an indicator tape or training aid to the crewman and directs him to identify the four sections of the indicator tape, to explain what each indicates, and to tell what action he would take when each section is exposed before firing and during firing. The crewman is required to do this within 2 minutes.

b. Examiner's Guide.

(1) Examiner IDENTIFY THE FOUR SECTIONS OF THE INDICATOR TAPE, EXPLAIN WHAT EACH INDICATES, AND TELL WHAT ACTION YOU WOULD TAKE WHEN EACH SECTION IS EXPOSED BEFORE FIRING AND DURING FIRING. (Starts time.)

(2) Crewman: Identifies the various portions of the tape, explains their meaning, and states action required:

(*a*) Two rough edges.

(*b*) One rough and one smooth edge.

(*c*) Two smooth edges.

(*d*) Two long notches.

(3) Examiner: Stops time.

(4) Time: 2 minutes.

241. Test on Identification and Use of Ammunition

a. Procedure. Three to five rounds of standard-type tank gun ammunition, with all nomenclature markings covered, are displayed before the crewman. The crewman is required to identify each round and state its primary use and how it is announced in a fire command. The crewman is required to do this within 30 seconds per round.

b. Examiner's Guide.

(1) Examiner: IDENTIFY EACH ROUND OF TANK GUN AMMUNITION: STATE ITS PRIMARY USE AND HOW IT IS ANNOUNCED IN A FIRE COMMAND. (Start time.)

(2) Crewman: Identifies each round and states its primary use and how it is announced in a fire command.

(3) Examiner: Stops time.

(4) Time: 30 seconds per round.

242. Test of Checking and Adjusting Firing Mechanism

Note. This test is applicable only when the tanks of a unit have machinegun solenoids and main gun firing linkage that are adjusted by the crew.

a. Procedure. In preparation for the test, the coaxial and cupola-mounted machinegun solenoids and main gun firing linkage are adjusted so that the guns will not fire. The examiner directs the crewman to turn on and actuate the firing switches and triggers and to adjust the solenoids and linkage so that the gun will fire. Three minutes are allowed for each gun that must be adjusted.

b. Examiner's Guide.

(1) Examiner: CHECK FIRING SWITCHES AND ADJUST MACHINEGUN SOLENOIDS AND MAIN GUN FIRING LINKAGE. (Starts time.)

(2) Crewman: Performs the checks and adjustments and announces COMPLETE.

(3) Examiner: Stops time.

(4) Time: 3 minutes per gun.

Note. Correct adjustment is required.

243. Test on Boresighting and Zeroing Main Gun

a. Procedure. For this test, a 6 x 6-foot panel target with an 8-inch bull's-eye and the appropriate size circle is set up at the boresighting and zeroing range in front of the tank. A three-round shot group is shown by three holes (or dots) on the target. A sample target is shown in figure 115. To conduct the exercise, the examiner places the computer or ballistic unit and the boresight knobs of the primary and the secondary direct-fire sights out of adjustment. The crewman is required to boresight and zero the gun with both these sights, using the prescribed procedure.

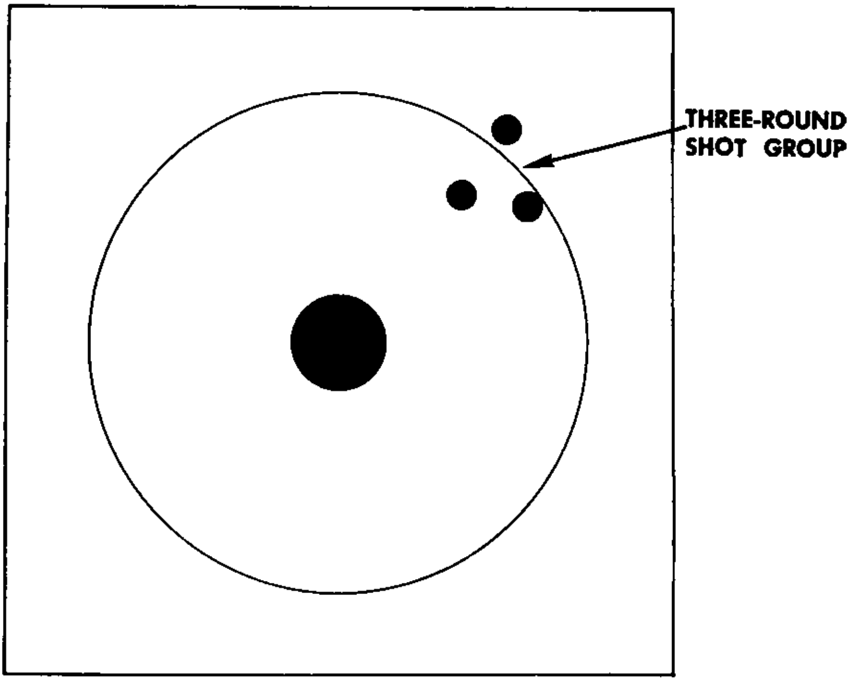


Figure 115. Target for test on boresighting and zeroing the main gun.

b. Examiner's Guide.

(1) Examiner: BORESIGHT MAIN GUN (indicates target and range to target).

(2) Crewman: Performs necessary steps to make boresight adjustment and announces COMPLETE (examiner sights through tube while gunner lays on the target).

(3) Time: No time limit.

Note. Correct procedure, to include accuracy of lay, is mandatory.

(4) Examiner: APPLY EMERGENCY ZERO TO THE PRIMARY SIGHT.

Note. Applicable only to certain type tanks.

(5) Crewman: Unlocks the boresight knobs and indexes the correct setting; then locks knobs and announces COMPLETE.

(6) Time: No time limit.

Note. Accuracy is required.

(7) Examiner: SIMULATE ZEROING MAIN GUN.

(8) Crewman: Indexes proper ammunition (and range if necessary), lays on the target, and simulates firing three rounds. Announces COMPLETE.

(9) Time: No time limit.

Note. Proper procedure, to include accuracy of lay and correct indexing of range and ammunition, is mandatory.

(10) Examiner: THE LOCATION OF YOUR THREE-ROUND SHOT GROUP IS INDICATED BY THE THREE DOTS ON THE TARGET. COMPLETE THE ZEROING PROCEDURE, TO INCLUDE FIRING A CHECK ROUND AND ZEROING THE SECONDARY SIGHT.

(11) Crewman: Lays on aiming point, unlocks boresight knobs of the primary sight, moves aiming cross to center of shot group, locks the knobs, re-lays on the aiming point by use of the gun controls, and simulates firing one round.

(12) Examiner: YOUR CHECK ROUND HIT WITHIN THE PRESCRIBED DISTANCE OF THE AIMING POINT.

(13) Crewman: Unlocks boresight knobs of secondary sight, moves the appropriate point of the reticle onto the aiming point, locks the boresight knobs, and announces COMPLETE.

(14) Time: No time limit.

Note. Accuracy is required.

244. Test on Boresighting and Zeroing Coaxial Machinegun

a. Procedure. For this test an E-type target is set up 800 meters (yards) in front of the tank and a 6 x 3-foot piece of target cloth is laid out approximately 200 meters (yards) short of and on line with the target to represent a machinegun burst. For boresighting the coaxial machinegun, the main gun target is used. A sample setup is shown in figure 116. The coaxial machinegun is properly mounted and the examiner places the coaxial machinegun (and sight on tanks with a separate sight for the coaxial machinegun) out of adjustment.

b. Conduct. The crewman is required to boresight and zero the coaxial machinegun using the prescribed procedure.

c. Examiner's Guide.

(1) Examiner: BORESIGHT COAXIAL MACHINEGUN (indicates target).

(2) Crewman: Performs necessary steps to make boresight adjustment and announces COMPLETE.

Note. The primary sight is laid on the same target used to boresight the main gun, by use of the gun controls. The coaxial machinegun is laid on the aiming point by use of the traversing and elevating controls on the mount. Then if a separate sight is available for the coaxial machinegun, it is moved to the aiming point by use of its boresight knobs.

(3) Time: No time limit.

Note. Correct procedure, to include accuracy of lay, is mandatory.

(4) Examiner: ZERO COAXIAL MACHINEGUN (indicates target and range to target).

(5) Crewman: Indexes proper ammunition and range and simulates firing a burst.

(6) Examiner: Points out simulated burst.

(7) Crewman: Makes necessary adjustments.

Note. The gun is moved by using the controls on the mount so that the beaten zone will bracket the target. If the crewman moves the gun in the appropriate direction, he will be considered correct, as the exact amount of movement can be determined only by firing. The crewman simulates firing another burst to check the adjustment.

(8) Time: No time limit.

Note. Correct procedure is mandatory.

245. Test on Boresighting and Zeroing Cupola-Mounted Machinegun

Note. This test is applicable only on tanks equipped with a cupola-mounted machinegun.

a. Procedure. For this test, a 6 x 6-foot panel target is set up

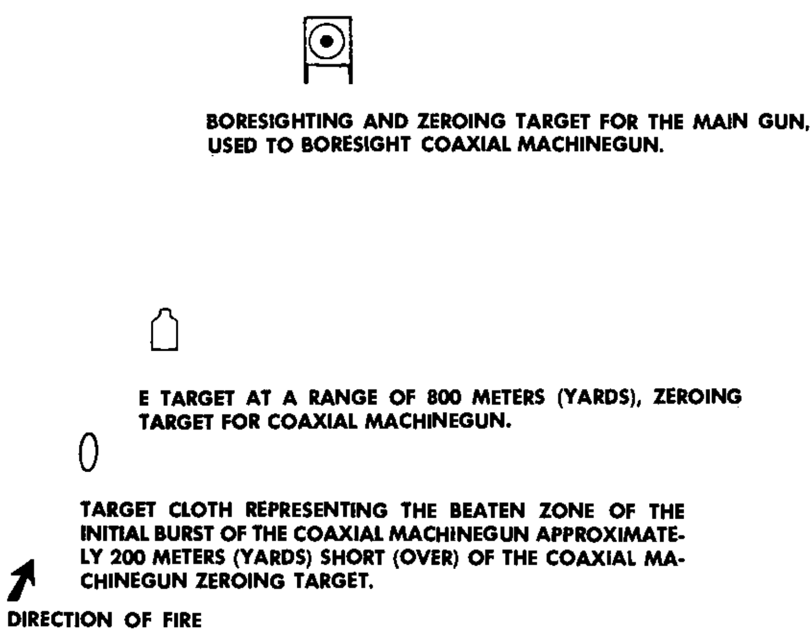


Figure 116. Setup for test on boresighting and zeroing the coaxial machinegun.

500 meters (yards) in front of the tank. The target must have an 8-inch bull's-eye, 18-inch circle, and holes (or dots) representing the shot group and check rounds. A sample target is shown in figure 117. The caliber .50 machinegun is properly mounted and the examiner places the sight out of adjustment.

b. Conduct. The crewman is required to boresight and zero the cupola-mounted machinegun using the prescribed procedure.

c. Examiner's Guide.

(1) Examiner: BORESIGHT CUPOLA-MOUNTED MACHINEGUN (indicates target).

(2) Crewman: Performs necessary steps to make boresight adjustment and announces COMPLETE.

(3) Time: No time limit.

(4) Examiner: ZERO CUPOLA-MOUNTED MACHINEGUN.

(5) Crewman: Simulates firing shot group.

(6) Examiner: Points out shot group.

(7) Crewman: Refers sight to shot group and simulates firing check rounds.

(8) Time: No time limit.

Note. Correct procedure and accuracy of lay are mandatory.

246. Test on Direct Laying and Sensing Adjustment

a. Procedure.

(1) *Preparation.* For this test, three 6 x 6-foot panels with tank targets about 4 feet long and 2 feet high are set up at a minimum distance of 300 meters in front of the tank. Two of the panels are marked with a red dot, which represents a shot that has missed the tank. On the first panel, the red dot is located about 1 foot above the tank and near the left edge of the panel, and on the second, 1 foot below the tank and near the right edge of the panel. A sample target layout is shown in figure 118.

(2) *Engagements.* The crewman is twice required to engage the three targets in response to initial fire commands issued by the examiner. The crewman first engages the three targets using the primary sight. Then he engages the three targets using the secondary sight. When engaging the first two targets, the crewman will use the primary method of sensing adjustment, assuming that the red dot on each panel is the first round fired. When engaging the third target, he will use the alternate method of sensing adjustment.

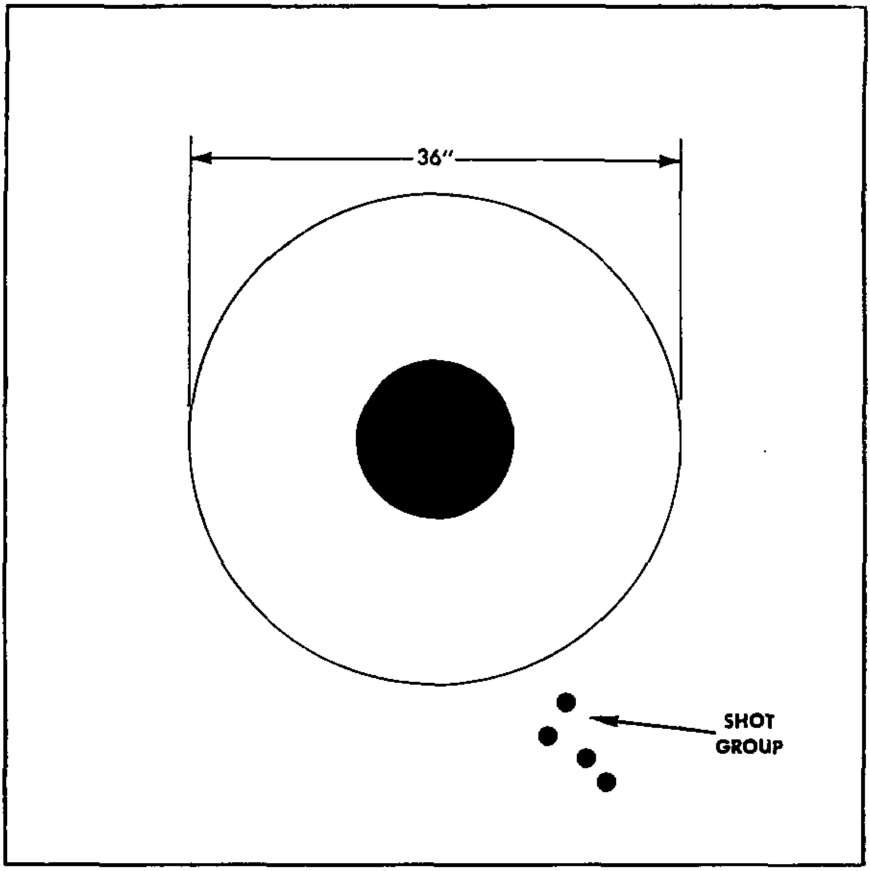


Figure 117. Target for test on boresighting and zeroing the cupola-mounted machinegun.

(3) *Conduct.*

(*a*) The examiner will brief the crewman on the series of engagements. When the crewman is ready, the examiner issues an initial fire command while laying the gun for direction and simulates ranging (on tanks not equipped with a rangefinder, a range element is included in the command). The crewman is required to—

1. Turn on the main gun switch.

Note. Turret power switch should be on before this exercise begins.

2. Index the proper ammunition (and range if necessary).

3. Announce IDENTIFIED.

4. Position the reticle to facilitate ranging by the tank commander (when applicable).

5. Make the final, precise lay (after command FIRE).
6. Announce ON THE WAY.
7. Simulate firing one round. (The red dot on the panel indicates a miss.)
8. Apply the primary method of sensing adjustment.
9. Announce ON THE WAY, and simulate firing a second round.

(*b*) This sequence is repeated for the second target. Twenty seconds are allowed for completion of each of the first two engagements.

(*c*) The sequence for engagement of the third target is identical; however, after simulating firing round, the crewman announces LOST and receives a subsequent fire command. He then applies the corrections given by the examiner, announces ON THE WAY, and simulates firing a second round. Thirty seconds are allowed for the completion of third engagement.

(*d*) The series of three engagements is repeated with the secondary sight in the same manner; however, the examiner must include a range element in the fire command on all type tanks. The same time limits are allowed for each type of engagement.

b. Examiner's Guide.

(1) Examiner: Issues appropriate fire command. (Starts time on announcing ammunition element.)

(2) Crewman: Turns on main gun switch; indexes appropriate type of ammunition (and range, if necessary); announces IDENTIFIED; positions the reticle for ranging (on rangefinder-equipped tanks); makes the final, precise lay; announces ON THE WAY; and simulates firing the first round.

(3) Examiner: Checks the initial lay and indicates tracer in relation to target.

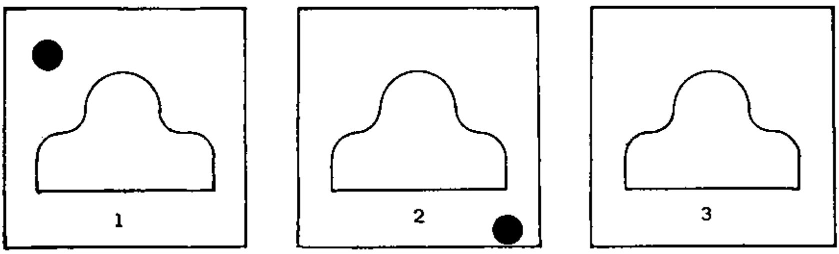


Figure 118. Target layout for direct laying and adjustment of fire.

(4) Crewman: Applies primary method of sensing adjustment, announces ON THE WAY, and simulates firing the second round.

(5) Examiner: Stops time and checks for accuracy in applying the adjustment.

(6) Time: 20 seconds.

Note. Proper procedure, to include exact sequence and accuracy of lay, is mandatory. Procedures described in (1) through (6) above, are repeated for the engagement of the second target.

(7) Examiner: Issues appropriate fire command. (Starts time on announcing ammunition element.)

(8) Crewman: Turns on the main gun switch, indexes appropriate type of ammunition (and range, if necessary), announces IDENTIFIED, positions the reticle for ranging (on rangefinder-equipped tanks), makes the final, precise lay, announces ON THE WAY, simulates firing the first round, and announces LOST.

(9) Examiner: Checks initial lay, announces an appropriate range sensing, and issues a subsequent fire command: (RIGHT) (LEFT) 3, (ADD) (DROP) 200, (400 if initial range was greater than 1,500 on tanks without a rangefinder), FIRE. (Starts time on command FIRE.)

(10) Crewman: Applies correction, announces ON THE WAY, and simulates firing the second round.

(11) Examiner: Stops time and checks for accuracy in applying adjustment.

(12) Time: 30 seconds.

Note. Proper procedure, to include exact sequence and accuracy of lay, is mandatory. Procedures described in (7) through (12) above, are repeated using the secondary sight.

247. Test on Non-Sensing Method of Adjustment

a. Procedure. For this test, a 6 x 6-foot panel with a tank target about 4 feet long and 2 feet high is set up a minimum distance of 300 meters in front of the tank.

Note. The same target layout used for sensing adjustment (fig. 118) may be used for this test.

b. Engagements. One complete drill is performed considering the target as stationary (fig. 63) and one considering it as a moving target (fig. 70).

c. Examiner's Guide.

(1) Examiner: Issues appropriate fire command. (Starts time on command FIRE.)

(2) Crewman: Performs gunner's duties and appropriate adjustment drill.

(3) Time: Thirty seconds for each engagement regardless of whether the target is considered stationary or moving. (Stop time after last announcement of ON THE WAY.)

248. Test on Preparing and Firing From a Range Card

a. Procedure.

(1) *Preparation.* For this test, 5 targets with 1-inch bull's-eyes are placed or drawn on a vertical surface about 25 meters in front of the tank; each target is set at a different elevation so as to provide plus and minus quadrant readings. A sample target layout is shown in figure 119. The center target is used as the reference point. The azimuth indicator is checked for accuracy. A range card, with data to all of the targets, is prepared.

(2) *Conduct.* The examiner indicates the reference point to the crewman, who lays on the reference point, zeroes the azimuth indicator and gunner's aid, and announces the quadrant elevation. The examiner then indicates two targets to the crewman, who lays on the targets designated and announces the quadrant elevation (plus or minus) and deflection (right or left). No time limit is placed on determination of this data. The examiner then covers the direct-fire sights and, using the range card data, issues a fire command to engage one of the remaining two targets. The crewman lays the gun as directed by this fire command. Twenty seconds are allowed for the engagement of this target on tanks with an elevation

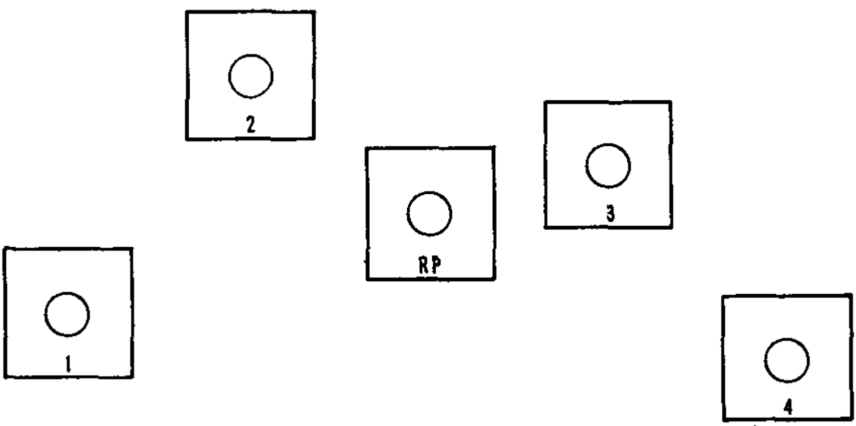


Figure 119. Target layout for range card.

quadrant and 30 seconds when a gunner's quadrant must be used. The examiner then issues a fire command for the remaining target, and the crewman repeats the procedure.

b. Examiner's Guide.

(1) Examiner: Indicates reference point and targets to which the crewman is to determine data for range card.

(2) Crewman: Lays on reference point, zeroes azimuth indicator and gunner's aid, and announces the quadrant elevation. He then lays on each target, determines data for each in turn, and announces the quadrant elevation and deflection for each target.

Note. Accuracy is of prime importance. A 1-mil tolerance may be permitted when readings to the nearest whole mil are in doubt. The gunner's quadrant will be used only when the tank has no elevation quadrant.

(3) Time: No time limit.

(4) Examiner: GUNNER, HE (HEP), QUADRANT (PLUS OR MINUS SO MUCH) DEFLECTION (SO MUCH) RIGHT (LEFT), TROOPS, FIRE. (Starts time.)

(5) Crewman: Turns on firing switch, indexes quadrant elevation, lays for deflection, places quadrant on breech (if gunner's quadrant is used), centers bubble by moving gun in elevation, announces ON THE WAY, and simulates firing one round.

(6) Examiner: Stops time.

(7) Time: 20 seconds if elevation quadrant is used and 30 seconds if gunner's quadrant is used.

Note. Sequence and accuracy are of prime importance. Procedures described in (4) through (7) above, are repeated for a second target.

249. Test on Adjusting Headspace on Caliber .30 Machinegun

Note. This test is applicable only when the tanks of a unit are equipped with caliber .30 machineguns.

a. Procedure. The assembled caliber .30 machinegun, with improper headspace, is mounted in a tank. The crewman is required to correctly adjust the headspace within 2 minutes.

b. Examiner's Guide.

(1) Examiner: ADJUST HEADSPACE. (Starts time.)

(2) Crewman: Adjusts headspace and announces COMPLETE.

(3) Examiner: Stops time.

(4) Time: 2 minutes.

250. Test on Adjusting Headspace and Timing and Mounting on Caliber .50 Machinegun

Note. The portion of this test requiring adjustment of headspace and timing is applicable only when the tanks of a unit are equipped with caliber .50, HB, M2, machineguns.

a. Procedure. The assembled machinegun, with improper headspace and timing, is placed on the rear deck of the tank. The crewman is required to adjust the headspace and timing correctly within 4 minutes. He must then properly mount the machinegun.

b. Examiner's Guide.

(1) Examiner: ADJUST HEADSPACE AND TIMING. (Starts time.)

(2) Crewman: Adjusts headspace and timing, using proper tools and procedure. Announces COMPLETE.

(3) Examiner: Stops time.

(4) Time: 4 minutes.

(5) Examiner: MOUNT CALIBER FIFTY.

(6) Crewman: Mounts the caliber .50 machinegun, using the proper procedure.

(7) Time: No time limit.

Note. The examiner will assist in lifting the gun, as necessary.

251. Test on Misfire Procedure

a. Procedure. The crewman will assume the gunner's position and the examiner will be in the tank commander's position during the conduct of this test. When the crewman begins this test, the turrent power will be ON, the main gun firing switch ON, and the breech closed.

b. Examiner's Guide.

(1) Examiner: THE MAIN GUN HAS FAILED TO FIRE; PERFORM THE STEPS OF THE MISFIRE PROCEDURE. (Starts time and cocks gun, if applicable, for each firing attempt.)

(2) Crewman: Turns off the main gun switch and announces MISFIRE. Turns on the main gun switch and attempts to fire with the appropriate trigger; turns off the main gun switch and announces MISFIRE. Makes the last attempt to fire manually on tanks with a percussion mechanism and with the auxiliary unit on tanks that have electric firing; announces MISFIRE.

(3) Examiner: Stops time.

(4) Time: 30 seconds.

252. Test on Safety and Control Measures

a. Procedure. For this test, a tank, a drill cartridge, a tarpaulin, and a flag set are required. The tank gun is positioned to the front, the drill cartridge is placed on a tarpaulin laid adjacent to the tank, and the flags are laid on top of the turret. The crewman is required to demonstrate and explain various safety precautions and control measures.

b. Examiner's Guide.

(1) Examiner: DEMONSTRATE THE PROPER METHOD OF CARRYING AND HANDLING AMMUNITION AND PASS IT TO ME. (Assists crewman by receiving round on tank.)

(2) Crewman: Takes round from tarpaulin, carries it to tank, and hands it to examiner. Round must be handled properly.

(3) Time: No time limit.

(4) Examiner: YOU ARE THE LOADER. DEMONSTRATE THE PROPER METHOD OF MOUNTING THE TANK (ON A STATIONARY TANK FIRING RANGE) (ON A MOVING TANK FIRING RANGE). (The examiner may specify either method.)

(5) Crewman: Mounts the tank in the proper manner and moves to the loader's position.

(6) Time: No time limit.

(7) Examiner: DEMONSTRATE THE PROPER METHOD OF STOWING A ROUND IN THE READY RACK. (Passes round to crewman.)

(8) Crewman: Receives, stows, and locks round in ready rack.

(9) Time: No time limit.

(10) Examiner: DEMONSTRATE THE SIGNAL FLAGS TO BE DISPLAYED (IN THE EVENT OF A MISFIRE) (WHEN FIRING) (WHEN PREPARING TO FIRE) (IN THE EVENT OF A MALFUNCTION WHEN ALL WEAPONS ARE CLEAR) (WHEN YOU ARE NOT FIRING).

(11) Crewman: Displays the appropriate flag signal.

(12) Time: No time limit.

(13) Examiner: DEMONSTRATE THE PROPER METHOD OF DISMOUNTING THE TANK ON A MOVING (STATIONARY) TANK FIRING RANGE. (Requires method opposite to (4) above.)

(14) Crewman: Dismounts in the proper manner.

(15) Time: No time limit.

Note. On all requirements in the preliminary gunnery examination with no time limit, the crewman will be informed to cease action if it becomes obvious that he does not know how to perform the requirement.

Section IV. TANK CREWMAN GUNNERY QUALIFICATION—SUBCALIBER FIRING

253. General

a. Subcaliber firing is conducted with the coaxial machinegun to simulate main gun firing. Machineguns must be tightly secured and dispersion must not exceed 2 inches from the center of impact. These exercises are fired single-shot throughout and ammunition must be loaded with alternate dummy cartridges or fired with a single-shot device. Targets are physically scored during all subcaliber record firing and the targets for tables I and II (except the zeroing target) should be pasted or replaced after each crewman fires. No credit is given for rounds fired after the time limit prescribed for the exercise.

b. A distance of 60 meters from weapon to target is prescribed for the subcaliber exercises (fig. 136). Range and ammunition requirements may be modified to enable units to use permanent range facilities now available. However, if the gun-target distance is changed, the size of the targets must be modified in proportion to the change.

254. Table I—First-Round-Hit Exercises

a. The purpose of these exercises is to test, with the coaxial machinegun, the crewman's ability to lay and fire the tank gun with a correct sight picture, prior to his firing service ammunition.

b. In this exercise the crewman, as gunner, first zeroes the primary sight and secondary sight with the coaxial machinegun. Then, using the primary sight, he fires 10 exercises, attempting to obtain a first-round-hit on each of 10 targets.

Note. Some tanks have a separate sight for use with the coaxial machinegun, but as subcaliber exercises are performed to simulate firing the main gun, this sight is *not* used in these exercises.

c. In the first-round-hit exercises, the crewman fires alternately at two silhouettes on each of which there are five consecutively numbered circle-type targets each consisting of a 4-inch circle and an 8-inch circle. A sample target layout is shown in figure 120.

d. Sight adjustment for subcaliber firing with the coaxial

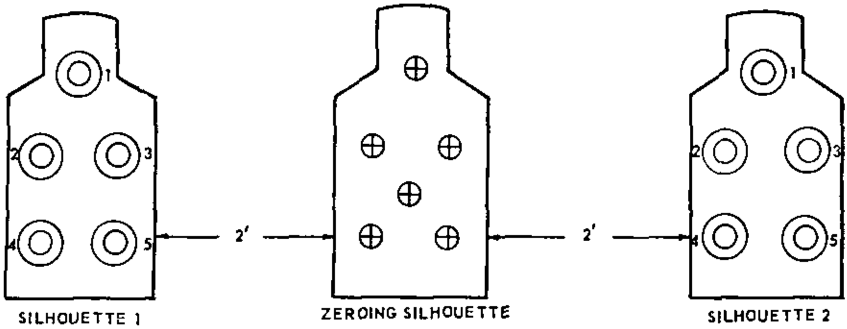


Figure 120. Target layout for table I.

machinegun is generally the same as for the main gun (pars. 52 and 54) except that superelevation is introduced into the fire control system for boresighting as well as zeroing. This procedure properly alines the sights for short range firing with a service firing range indexed to provide a starting point for indexing range errors, when applicable, and to further simulate main gun firing. An emergency zero is not used on any type tank for subcaliber firing. To facilitate boresighting and zeroing for subcaliber firing, the receiver end of the machinegun is moved as far left as possible by use of the traversing and elevating mechanisms on the mount. Boresighting is then accomplished by sighting through the barrel, laying on any target of the zeroing silhouette, and adjusting the sights on this target. On rangefinder-equipped tanks, the primary sight is adjusted with the main gun zeroing range indexed in the rangefinder (with the computer switch ON) and the appropriate type ammunition indexed in the computer. On tanks without a rangefinder, the main gun zeroing range and appropriate type ammunition are indexed in the ballistic unit. The secondary sight is adjusted with the appropriate range line on the boresight point. The crewman fires a three-round shot group at the boresight point, using the same sight picture for each round fired. He then unlocks the boresight knobs on the primary sight, refers the aiming cross to the center of the shot group, and locks the knobs. The crewman then fires a check round. It must hit within the 4-inch circle. If it does not, the zeroing procedure is repeated. When zeroing has been accomplished, the crewman unlocks the boresight knobs of the secondary sight, lays the appropriate range line on the aiming point, and locks the boresight knobs. (When the examiner checks this sight, he should induce a range error of plus or minus 200 to prepare this sight for table II. He should also refer the reticle in his direct-fire sight to the aiming point for use in checking the crewman's actions.) There is no score for this part of the table; however, accuracy has a distinct bearing on the remainder of table I.

e. In the first-round-hit firing, the crewman, using the primary direct-fire sight, the zero that he established in the zeroing procedure, and either his power or his manual controls, fires 10 exercises of 1 round each, 1 at each target, alternating between the 2 silhouettes for each exercise. Before firing, the crewman lays on the top zeroing target. At the command COMMENCE FIRING, he fires at target 1 on the left silhouette, then at target 1 on the right silhouette, and then at target 2 on the left silhouette, continuing in this manner until he has fired at all targets on both silhouettes. The emphasis is on speed and accuracy. If the crewman properly zeroes and uses the correct sight picture, he should obtain a hit within the 4-inch circle of each target. The crewman must complete the 10 exercises in 1 minute.

f. The exercises are scored as shown in table I.

Table I

Possible score: 100
Minimum satisfactory score: 70

Exercise	No. of rounds	Firing and scoring procedures
Zeroing	10	Fire a shot group, refer sights, and verify. No score. No time limit.
First-round hit.	10	Fired with primary sight. One round at each target in sequence, alternating between silhouettes after each round. Ten points for each hit in 4-inch circle; 5 points for each hit in 8-inch circle. Time: one minute.

g. See figure 121 for illustration of an appropriate score card.

255. Table II—Sensing Adjustment Exercises

a. The purpose of these exercises is to test the crewman's ability to employ the primary and alternate methods of sensing adjustment before he fires service ammunition.

b. These exercises are fired by the crewman, immediately following table I, with the zero established in that table and using either his power or his manual controls. The crewman fires at 2 silhouettes, each with 5 circle-type targets. Each target consists of a 4-inch circle and an 8-inch circle. At three targets (1–3) on each silhouette, he will apply the primary method of sensing adjustment with the primary sight (*c*(1) below). At one target (4) on each silhouette, he will apply the primary method of sensing adjust-

UNIT ______________ NAME ______________

DATE ______________ GRADE ______________ SN ______________

SCORE CARD: TABLE I—FIRST-ROUND-HIT EXERCISES

100 POINTS POSSIBLE

SILHOUETTE	NUMBER OF ROUNDS	POSSIBLE	EXERCISE					SCORE
			1	2	3	4	5	
1	5	50						
2	5	50						
						TOTAL SCORE		

Notes.

1. Ten points for each hit in 4-inch circle.
2. Five points for each hit in 8-inch circle.
3. Time limit: 1 minute. No score for rounds fired after time limit.

Minimum Satisfactory Score .... 70 points.

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Figure 121. Scorecard for table I.

ment with the secondary sight (*c*(2) below). At one target (5) on each silhouette, he will apply the alternate method of sensing adjustment with the primary sight (*c*(3) below). The crewman fires at all 5 targets in sequence on 1 silhouette and then at the targets on the other silhouette in the same manner (table II, note 1, below). A sample target layout is shown in figure 122.

c. The following procedure is used:

(1) *Primary method of sensing adjustment* (*primary sight*) (*targets 1–3*). Without disturbing the zero established in table I, the examiner induces a range error of plus or minus 200, by indexing in the rangefinder or by announcement in his initial fire command on tanks not equipped with a rangefinder. (Check to insure the announced range is indexed.) This range error, which should be varied, will cause the crewman to miss with the first round. The examiner announces an initial fire command for each engagement, giving the target number for the description element. The crewman fires, notes the point on the sight reticle where the tracer appeared in relation to the target, applies the primary method of sensing adjustment, and fires the second round. He should obtain a second round hit in the 4-inch circle. The crewman is timed from the command FIRE of the initial fire command. He has 10 seconds to complete the firing.

(2) *Primary method of sensing adjustment* (*secondary sight*)

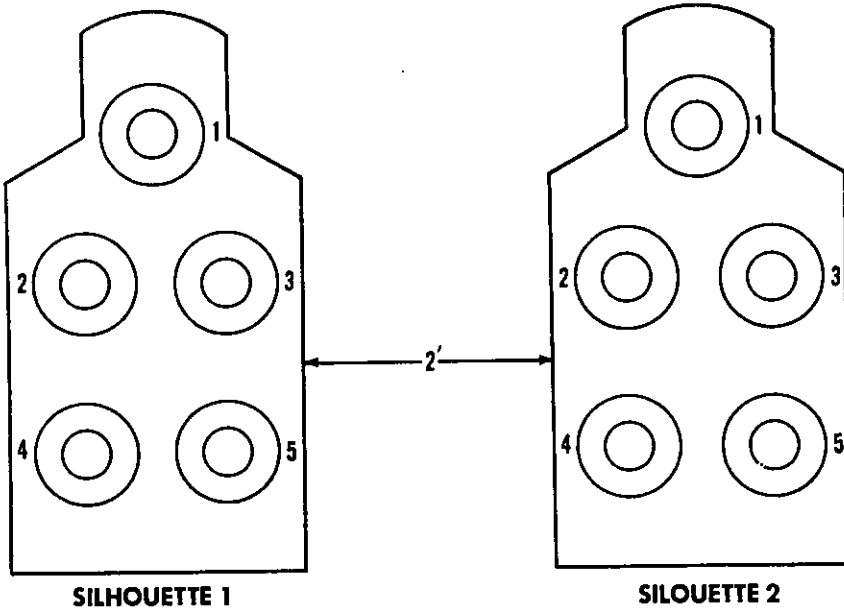

Figure 122. Target layout for table II.

(*target 4*). To make the crewman miss the 4-inch circle with the first round, the examiner induces a range error of plus or minus 200 when he checks the sight for the correct zeroing procedure. He then announces an initial fire command with a range element the same as the zeroing range. The crewman fires, notes the point on the reticle where the tracer appeared in relation to the target and, using the reticle in the secondary sight, applies the primary method of sensing adjustment, and fires the second round. He should obtain a second-round hit in the 4-inch circle. The crewman is timed from the command FIRE of the initial fire command. He has 10 seconds to complete the firing.

Note. During the engagement of targets 1 through 4, if the crewman cannot see the strike of the initial round, he announces LOST, at which time the examiner announces LOST, FIRE. The crewman fires a second round without adjusting and then fires a third round using the primary method of sensing adjustment. The third round is scored. The time limit for the complete engagement is not changed. During record firing at these four targets, only one LOST round per target is allowed.

(3) *Alternate method of sensing adjustment* (*primary sight*)

(*target 5*). Without disturbing the zero established in table I, the examiner indexes an incorrect range (plus or minus 200) in the rangefinder or announces an incorrect range in the initial fire command on tanks not equipped with a rangefinder. (Check to insure the announced range is indexed.) The crewman lays on the target, announces ON THE WAY, simulates firing, and announces LOST. The examiner announces a range sensing and issues a subsequent fire command to correct the range error. The crewman applies the correction, using the sight reticle, and fires. If a hit is not obtained in the 4-inch circle with the first round, the crewman applies the primary method of sensing adjustment and fires a second round. The crewman is timed from the command FIRE of the subsequent fire command. He has 10 seconds to complete the firing.

d. The exercise is scored as shown in table II.

Table II

Possible score: 100
Minimum satisfactory score: 70

Exercise	No. of rounds	Sight	Method of sensing adjustment	Scoring
1 and 6	2	Primary	Primary	10 Second round in 4-inch circle, 10 points; in 8-inch circle, 5 points.
2 and 7	2	Primary	Primary	10
3 and 8	2	Primary	Primary	10
4 and 9	2	Secondary	Primary	10
5 and 10	2	Primary	Alternate	10 First round in 4-inch circle, 10 points; second round in 4-inch circle, 5 points.

e. See figure 123 for illustration of an appropriate scorecard.

256. Table III—Moving Target Exercises

a. The purpose of these exercises is to test the crewman's ability to lead, track, and adjust fire by the primary method of sensing adjustment on moving targets, prior to his firing service ammunition.

b. In these exercises, the crewman is required to engage moving targets using the coaxial machinegun. The target speed is controlled, and the machinegun is zeroed to hit the target when one lead is taken.

c Targets are mounted on a 6 x 6-foot panel as shown in figure 124 The speed of the panels should be approximately 3 miles per

UNIT ________________ NAME ________________

DATE ________________ GRADE ____________ SN ________________

100 POINTS POSSIBLE

SCORE CARD: TABLE II—SENSING ADJUSTMENT EXERCISES

SILHOUETTE	NUMBER OF ROUNDS	POSSIBLE	EXERCISES					SCORE
			1&6	2&7	3&8	4&9	5&10	
1	10	50						
2	10	50						
						TOTAL SCORE		

Notes.

1. Score second round only on exercises 1-4 and 6-9. Ten points for each hit in 4-inch circle and five points for each hit in 8-inch circle.
2. Score exercise 5 and 10: Ten points for first-round hit in 4-inch circle, five points for second-round hit in 4-inch circle. Maximum of ten points.
3. No score for rounds not fired within 10 seconds after command FIRE of initial fire command for exercises 1-4 and 6-9, or of subsequent fire command for exercises 5 and 10.

Minimum Satisfactory Score .... 70 points.

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Figure 123. Scorecard for table II.

hour so that the crewman can track the target and has time to engage it while it is within the safety limits.

d. When a moving target is engaged, proper procedure is for the gunner to apply one lead. In this exercise, however, a normal lead of 5 mils is too long, because of the low speed of the target; therefore, the examiner introduces an error of one-half lead into each sight in order that a one-lead sight picture can be taken to hit the target. After firing check rounds at a stationary zeroing target, to insure that the zero of each sight is correct for the zeroing range, the examiner creates a false half-lead in each sight by moving the reticle to the *left* ½-lead (2½ mils) if the target is to move from right to left, and to the *right* if the target is to move from left to right. The examiner then fires a check round at a zeroing target on the moving panel with one lead. He adjusts the sights, if necessary, until he is able to hit within 2 inches of the center of the target with a one-lead sight picture, and slips the scale on the deflection boresight knob of the primary sight to the center of its adjustment.

Note. Zeroing with ½-lead requires that targets be engaged while moving in one direction only. Crewmen practice leading and tracking, without firing, when targets are moving in the opposite direction.

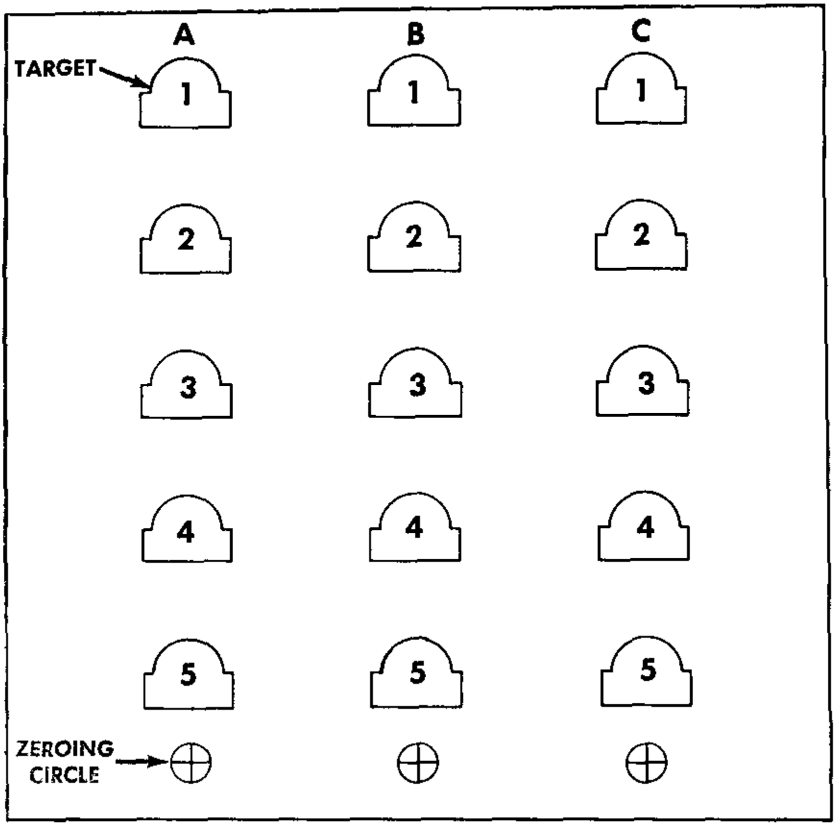

Figure 124. Moving targets for table III.

e. The exercises are conducted as follows:

(1) There are five exercises; one exercise is fired in manual traverse and four in power traverse.

(2) As the panel moves along the course, the examiner gives a fire command designating a target by number.

(*a*) For the first two exercises, the examiner indexes (announces on tanks not equipped with a rangefinder) the zeroing range. The crewman fires three rounds in each exercise, using the primary sight and applying the primary method of sensing adjustment if necessary. The crewman uses the manual controls for the first exercise and the power controls for the second. From the initial command FIRE, 15 seconds are allowed for each exercise. No score is allowed for rounds fired after time limit.

(*b*) For the third exercise, the examiner announces the zeroing range in his fire command. The crewman uses the secondary sight and the power controls. The exercise is fired, timed, and scored in the same manner as the first two exercises.

Note. During the first three exercises, if the crewman cannot sense a round, he will announce LOST. The examiner will then announce LOST, FIRE, and the crewman will complete the exercise. No additional rounds or time will be allowed.

(*c*) For the fourth exercise, the examiner indexes (announces on tanks not equipped with a rangefinder) plus or minus 200 from the zeroing range. The crewman fires three rounds, using the power controls, the primary sight, and the primary method of sensing adjustment. The first round is not scored. From the initial command FIRE, 15 seconds are allowed for the exercise.

(*d*) For the fifth exercise, the examiner introduces a lead error by moving the deflection boresight knob of the primary sight 2½ mils (either direction) and indexes (announces on tanks not equipped with a rangefinder) the zeroing range. The exercise is fired, timed, and scored in the same manner as the fourth exercise. (Before testing another crewman, the examiner must move the boresight knob back to its correct setting for one lead.)

Note. During the fourth and fifth exercises, if the crewman cannot sense the first round, he will announce LOST. The examiner will then announce LOST, FIRE, and the crewman will fire a second round without adjusting and a third and fourth round with the primary method of sensing adjustment. The third and fourth rounds will be scored. No additional time will be allowed. If a round other than the first is LOST, the procecedure will be the same as for the first three exercises.

f. The exercises are scored as shown in table III.

Table III

Possible score: 100
Minimum satisfactory score: 70

Exercise	No. of rounds	Sight	Method of sensing adjustment	Control	Scoring	
1	3	Primary	Primary	Manual	20	5 points for each hit. 5 points for correct tracking.
2	3	Primary	Primary	Power	20	
3	3	Secondary	Primary		20	
4	3	Primary	Primary		20	First round not scored. 10 points for second round hit. 5 points for third round hit. 5 points for correct tracking.
5	3	Primary	Primary		20	

g. See figure 125 for illustration of an appropriate scorecard.

UNIT ______________________ NAME ______________________________

DATE ____________________ GRADE ______________ SN ________________

SCORE CARD: TABLE III—MOVING TARGET EXERCISES

100 POINTS POSSIBLE

EXERCISE	NUMBER OF ROUNDS	POSSIBLE	PROPER TRACKING	TARGET HITS			SCORE
				1ST RD	2D RD	3D RD	
1	3	20					
2	3	20					
3	3	20					
4	3	20					
5	3	20					
				TOTAL SCORE			

Notes.

1. Five points for proper tracking.
2. Five points for each HIT except 10 points for second-round hit on exercises 4 and 5.
3. Time limit: 15 seconds. No score for rounds fired after time limit.

Minimum Satisfactory Score .... 70 points.

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EXAMINER OFFICER IN CHARGE

Figure 125. Scorecard for table III.

Section V. TANK CREWMAN GUNNERY QUALIFICATION—SERVICE FIRING

257. General

a. Service tables are fired in the order IV and V. The crewman should fire the service tables on the same tank.

b. Targets will be scored by the examiner, using the tank commander's direct-fire sight or binocular. Enough targets must be provided to preclude the possibility of erroneous scoring. The appropriate deduction will be made from the score when the time limit for an exercise is exceeded; however, all exercises will be completed.

258. Table IV—Stationary Target Exercises

a. These exercises are designed to test the crewman's ability to fire the tank gun at stationary targets (fig. 137). The crewman fires two rounds of ammunition to verify and refine the established zero for the main gun prior to firing the scored exercises. He fires these two rounds at a zeroing target set up at the correct range. He then fires four exercises in any sequence.

b. The exercises are conducted as follows:

(1) Exercise 1 is conducted with the primary sight. The examiner issues a battlesight initial fire command. The battlesight range will be 1,000 meters (yards). As the

range and type of ammunition have been indexed into the fire control system, the crewman lays on the center of vulnerability and fires. The first round should miss the target. The primary method of sensing adjustment is employed with the second round.

(2) Exercise 2 is conducted with the primary sight. The examiner indexes the correct range into the rangefinder or announces a correct range if the tank is not equipped with a rangefinder. The first round should hit the target. If not, a second round is fired employing the primary method of adjustment.

(3) Exercise 3 is conducted with the secondary sight. The examiner issues a fire command with the correct range element. The first round should hit the target. If not, a second round is fired employing the primary method of adjustment.

(4) For exercise 4, the examiner induces a 200-meter (-yard) range error into the rangefinder or announces this error if the tank is not equipped with a rangefinder. Given an initial fire command and using the primary sight, the crewman then simulates firing a round and announces LOST. The examiner announces a range sensing and issues a subsequent fire command with a 200-meter (-yard) range correction to compensate for the induced error, which, if correctly applied, will cause the first round fired to hit the target. The crewman fires a second round, applying the primary method of sensing adjustment, if necessary.

c. The exercises are scored as shown in table IV.

Table IV

Possible score: 100
Minimum satisfactory score: 70

Exercise	Target	Range in meters (yards)	No. of rounds	Sight	Method of sensing adjustment	Possible points
Zeroing	Zeroing target panel.	Zeroing range	(a)2	Primary	Primary	Unscored
1	3 x 5 ft.	1,200–1,300	(a)2	Primary	Primary	25
2	6 x 6 ft.	1,400–1,600	(a)2	Primary	(First-round hit).	25
3	6 x 6 ft.	1,400–1,600	(a)2	Secondary	(First-round hit).	25
4	6 x 6 ft.	1,500–2,000	(b)2	Primary	Alternate	25

[a] AP-T or TP-T.
[b] HE or HEP.

d. Points for each exercise are given as follows:

(1) *Exercise 1.*

(*a*) Completing exercise within 20 seconds of the command FIRE: 10.

(*b*) Target hit with second round: 15.

(2) *Exercises 2 and 3.*

(*a*) Completing exercise within 10 seconds of the command FIRE: 10.

(*b*) Target hit with first round: 15.

(*c*) Target hit with second round if first round misses the target: 5.

(3) *Exercise 4.*

(*a*) Completing exercise within 20 seconds from the command FIRE in the subsequent fire command: 10.

(*b*) Target hit with first round fired: 15.

(*c*) Target hit with second round fired if first round misses the target: 5.

Note. If the crewman cannot sense the first round fired in any exercise, he announces LOST. The examiner then announces a range sensing and issues a subsequent fire command, which the crewman applies using the sight reticle. In exercise 1, no additional time is allowed. In exercises 2, 3, and 4, if the first round misses the target, 10 additional seconds from the firing of the first round are allowed if the primary method of adjustment must be employed.

e. The tank is moved to a different firing position for each exercise (fig. 137) unless limited range facilities make this requirement too time-consuming.

f. See figure 126 for illustration of an appropriate scorecard.

259. Table V—Moving Target Exercises

a. These exercises are designed to test the ability of the crewman to hit moving targets with the tank gun. The crewman fires two rounds of ammunition to verify and refine the established zero for the main gun prior to firing the scored exercises. He fires these rounds at a zeroing target set up at the correct range. He then fires four exercises in any sequence. The primary method of sensing adjustment is used in each exercise. The second round is fired in each main gun exercise even if the first round is a target hit. To provide positive scoring, the number of tanks firing at any one time should correspond to the number of moving target panels.

b. The exercises are fired from a stationary tank at moving targets (6 x 6-foot panels) at known ranges varying from 700 to 1,500 meters (yards). Either a powered target or a towed

UNIT ____________ NAME ____________

DATE ____________ GRADE ____________ SN ____________

100 POINTS POSSIBLE

SCORE CARD: TABLE IV—STATIONARY TARGET EXERCISES

EXERCISE	POSSIBLE	COMPLETED IN TIME LIMIT	TARGET HITS		SCORE
			1ST RD	2D RD	
1	25		X		
2	25				
3	25				
4	25				
				TOTAL SCORE	

Notes.

1. Ten points for completing in the following time limits:
   Exercise 1: 20 seconds from initial command FIRE.
   Exercises 2 and 3: 10 seconds from initial command FIRE.
   Exercise 4: 20 seconds from command FIRE of subsequent fire command
2. Fifteen points for first-round hit in exercises 2, 3, and 4.
3. Fifteen points for second-round hit in exercise 1. Five points for second-round hit if first round misses in exercise 2, 3, and 4.

Minimum Satisfactory Score .... 70 points.

EXAMINER ____________ OFFICER IN CHARGE ____________

Figure 126. Scorecard for table IV.

target may be used. The target is exposed for approximately 300 meters and travels that distance at a constant speed of between 8 and 15 miles per hour.

c. The exercises are conducted as follows:

(1) *Exercises 1 and 2.* The examiner issues an initial fire command and indexes (announces if tank is not equipped with a rangefinder) the correct range. The crewman engages the designated target with two rounds of ammunition, using the primary sight and applying the primary method of sensing adjustment, if necessary. If the crewman is unable to sense the first round, he announces LOST. The examiner then announces his range sensing and issues a subsequent fire command. No additional time is allowed. The crewman may use either power or manual control.

(2) *Exercise 3.* Conducted in the same manner as exercises 1 and 2 except that range must be announced and the secondary sight is used.

(3) *Exercise 4.* Conducted in the same manner as exercises 1 and 2 except that a 200-meter (-yard) range error is indexed (announced if necessary).

d. The exercises are scored as shown in table V.

Table V

Possible score: 100
Minimum satisfactory score: 70

Exercise	Range in meters (yards)	No. of rounds	Sight	Method of sensing adjustment	Possible points
Zeroing	Zeroing range	[a]2	Primary	Primary	Unscored
1	700–1,500	[a]2	Primary	Primary	25
2	700–1,500	[a]2	Primary	Primary	25
3	700–1,500	[a]2	Secondary	Primary	25
4	700–1,500	[a]2	Primary	Primary	25

[a] AP–T or TP–T.

e. Points for each exercise are given as follows:

(1) *Exercises 1, 2, and 3.*

(*a*) Completing exercise within 20 seconds of the command FIRE: 5.

(*b*) Correct tracking: 5.

(*c*) Target hit with first round: 5.

(*d*) Target hit with second round: 10.

UNIT ______________ NAME ______________

DATE ______________ GRADE ______________ SN ______________

SCORE CARD: TABLE V—MOVING TARGET EXERCISES — 100 POINTS POSSIBLE

EXERCISE	POSSIBLE	COMPLETED IN TIME LIMIT	CORRECT TRACKING	TARGET HITS		SCORE
				1ST RD	2D RD	
1	25					
2	25					
3	25					
4	25			X		
				TOTAL SCORE		

Notes.

1. Five points for completing exercise within 20 seconds of initial command FIRE in all exercises.
2. Five points for correct tracking in all exercises.
3. Five points for first-round hit in exercises 1, 2, and 3.
4. Ten points for second-round hit in exercises 1, 2, and 3.
   Fifteen points for second-round hit in exercise 4.

Minimum Satisfactory Score .... 70 points.

______________ EXAMINER

______________ OFFICER IN CHARGE

Figure 127. Scorecard for table V.

(2) *Exercise 4.*

(*a*) Completing exercise within 20 seconds of the command FIRE: 5.

(*b*) Correct tracking: 5.

(*c*) Target hit with second round: 15.

f. See figure 127 for illustration of an appropriate scorecard.

Section VI. TANK CREW GUNNERY QUALIFICATION FIRING

260. General

a. Purpose. The purpose of tank crew gunnery qualification firing is to determine the crew's ability to employ all tank weapons effectively during both daylight and darkness.

b. Sequence of Firing.

(1) Each crew fires tables VI, VIIA, and VIIB twice. These tables are training exercises for developing crew proficiency and they afford the unit commander an opportunity to complete the organization and training of crews before firing tables VIIIA and VIIIB. The second firing of tables VI, VIIA, and VIIB should be scored to provide motivation for the crews and to furnish the unit commander with an indication of crew progress. The minimum satisfactory scores for these tables are guides to progress and satisfactory performance. If a crew has not attained the minimum satisfactory score on these tables but, in the opinion of the unit commander, has shown progressive improvement, it may be allowed to fire tables VIIIA and VIIIB.

(2) Tables VIIIA and VIIIB are fired for qualification once by each crew.

c. Crew Composition.

(1) The firing crew should be the assigned crew. However, crew assignments may be varied during the firing of tables VI, VIIA, and VIIB to provide an even distribution of skills among all crews in the unit.

(2) Crew composition should not be varied after the crew begins firing tables VIIIA and VIIIB.

d. Conduct of Exercises. The tank crew gunnery qualification course should be conducted over unimproved terrain so that the realism of normal cross-country firing may be obtained. Combat realism should be emphasized consistent with targets and range facilities available. Demolitions and surprise targets should also be used to add realism. The appropriate deduction will be made from the score when the time limit for an exercise is exceeded; however, all exercises will be completed.

e. Critique of Exercises. Examiners will critique each crew after it has fired each table, using the completed score card as the basis for the critique.

f. Corrective Training. As the firing progresses, commanders will make every effort to correct deficiencies noted so as to attain maximum performance when crews fire tables VIIIA and VIIIB.

g. Range facilities available to the unit may not permit firing the main gun from a series of firing positions as required in the crew field firing and crew proficiency tables. Under such conditions, unit commanders should make one of the following modifications, listed in order of desirability.

(1) Fire main gun exercises from a firing line in a manner similar to table IV firing (fig. 137) and machinegun exercises from a series of positions as prescribed in the crew qualification tables.

(2) Fire machinegun exercises of all crew qualification tables as prescribed and simulate firing the main gun exercises.

Note. Scoring will be modified as appropriate and notations in individual records will indicate that modified main gun exercises or the machinegun exercises only were fired.

261. Table VI—Crew Machinegun Exercises (Day)

a. The purpose of these exercises is to develop crew coordination and the ability to engage moving and stationary targets with tank machineguns from a moving and stationary tank. This table should be conducted on a range similar to the one used for crew field firing exercises (fig. 142).

b. Each crew will make a dry run of the exercises before its first firing run. This can be done in conjunction with the firing run of another tank. On the dry run, the examiner will indicate the location of the targets and what each target represents.

c. The tank crew inspects its vehicle and equipment. Ammunition is stowed and communication is established with the safety officer. An outline of the exercises is shown in table VI. The sequence may be varied to suit the available range facility.

Table VI

Possible score: 450
Minimum satisfactory score: 315

Exercise	Weapon	Range in meters (yards)	No. of rounds	Target description	Possible points
1	Coax MG	200–400	50	Troops (10 E-type)	90
2	Coax MG	600–800	50	Machinegun (3 x 5 ft.)	90
3	Coax MG	600–800	50	Moving Truck (6 x 6 ft.)	90
4	Coax MG	500–600	100	Troops (10 E-type)	90
5	Cal .50 MG	1,000–1,200	50	Truck (6 x 6 ft.)	90

d. Points for each exercise are given as follows: (No partial credit except as indicated.)

(1) *Exercises 1, 2, 3, and 4.*

(*a*) Completing exercise within time limit: 25.

(*b*) Identifying target without assistance from examiner: 5.

(*c*) Correct fire commands, crew duties, and technique of fire (cut 5 points for each error) : 30.

(*d*) Target effect: 30.

(2) *Exercise 5.*

(*a*) Completing exercise within time limit: 25.

(*b*) Identifying target without assistance from examiner: 5.

(*c*) Correct procedure and technique of fire (cut 5 points for each error) : 30.

(*d*) Target effect: 30.

e. Exercises are conducted as follows, after the tank crew has been ordered to move out.

(1) *Exercise 1 (troops)*. The targets appear and are engaged with the coaxial machinegun as the tank continues to move. The exercise must be completed within 55 seconds from the time the tank commander identifies the target area.

(2) *Exercise 2 (machinegun)*. The target appears and the tank is halted. The target is engaged with the coaxial machinegun. The exercise must be completed within 55 seconds from the command to halt the tank. When the exercise is completed, the tank moves out.

(3) *Exercise 3 (moving truck)*. The moving target appears and the tank is halted. The target is engaged with the coaxial machinegun. The exercise must be completed within 55 seconds from the command to halt the tank. When the exercise is completed, the tank moves out.

(4) *Exercise 4 (troops)*. The targets appear and are engaged with the coaxial machinegun as the tank continues to move. The exercise must be completed within 1 minute, 15 seconds, from the time the tank commander identifies the target.

(5) *Exercise 5 (truck)*. The target appears and the tank is halted. The target is engaged with the caliber .50 machinegun. The exercise must be completed within 1 minute from the command to halt the tank.

UNIT ________________ TANK CREW ________________

COMMANDER ________________

DATE ________________ GUNNER ________________

DRIVER ________________

LOADER ________________

SCORE CARD: TABLE VI—CREW MACHINEGUN EXERCISES 450 POINTS POSSIBLE

EXERCISE	NUMBER OF ROUNDS	ITEM AND POSSIBLE POINTS		SCORE
1 Troops	50 Coax	Completing within 55 seconds	25	______
		Target identification	5	______
		Fire commands, crew duties, and technique of fire	30	______
		Target effect	30	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
2 Machinegun	50 Coax	Completing within 55 seconds	25	______
		Target identification	5	______
		Fire commands, crew duties, and technique of fire	30	______
		Target effect	30	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
3 Moving Truck	50 Coax	Completing within 55 seconds	25	______
		Target identification	5	______
		Fire commands, crew duties, and technique of fire	30	______
		Target effect	30	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
4 Troops	100 Coax	Completing within 1 minute and 15 seconds	25	______
		Target identification	5	______
		Fire commands, crew duties, and technique of fire	30	______
		Target effect	30	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
5 Truck	50 Cal .50	Completing within 1 minute	25	______
		Target identification	5	______
		Correct procedure and technique of fire	30	______
		Target effect	30	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
		TOTAL SCORE		______

Minimum Satisfactory Score .... 315 points.

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EXAMINER OFFICER IN CHARGE

Figure 128. Scorecard for table VI.

f. Control Measures.

(1) The safety officer follows the firing tanks in a radio-equipped vehicle.

(2) Radio communication is maintained between the safety officer and the firing tanks. An examiner rides each firing tank and has communication with the crew and the safety officer.

(3) The firing tank should move at least 50 meters between exercises.

(4) Upon completion of the last exercise, all weapons are cleared.

g. The examiner will time and score the tank crew, using a binocular to determine target effect. An appropriate scorecard is shown in figure 128.

262. Table VIIA—Crew Field Firing Exercises (Day)

a. The purpose of these exercises is to develop the crew's ability to engage moving and stationary targets during daylight with all tank weapons (fig. 139).

b. A battlesight of 1,000 meters (yards) and the appropriate type ammunition is indexed. Ammunition is stowed and communication is established with the safety officer. An outline of the exercises is shown in table VIIA. The sequence may be varied to suit the available range facility.

c. Each crew will make a dry run of the exercises before making the first firing run. This can be done in conjunction with the firing run of another tank. On the dry run, the examiner will indicate the location of the targets and what each target represents, but he will not reveal the range to the targets or allow ranging on the targets on rangefinder-equipped tanks.

Table VIIA

Possible score: 700
Minimum satisfactory score: 490

Exercise	Weapon	Range in meters (yards)	No. of rounds	Target description	Possible points
1	Main gun	900–1,100	([a]) 2	Moving tank (6 x 6 ft. panel)	115
2	Coax MG	600– 800	50	Moving truck (3 x 5 ft. panel).	90
3	Main gun	1,500–2,000	([b]) 2	Antitank (3 x 5 ft. panel)	115
4	Main gun	1,500–2,000	([a]) 2	Stationary tank (6 x 6 ft. panel).	115
5	Coax MG	200– 400	50	Troops (10 E-type)	90
6	Cal .50 MG	1,200–1,400	50	Antitank (3 x 5 ft. panel)	90
7	Cal .50 MG	1,000–1,500	50	Suspected area	85

[a] AP-T or TP-T.
[b] HE or HEP.

d. Points for each exercise are given as follows: (No partial credit except as indicated.)

(1) *Exercises 1, 3, and 4.*

(*a*) Completing exercise within time limit: 30.

(*b*) Identifying target without assistance of examiner: 5.

(*c*) Correct fire commands and crew duties (cut 5 points for each error) : 20.

(*d*) Each target hit: 30.

(2) *Exercises 2 and 5.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 5.

(*c*) Correct fire commands, crew duties, and technique of fire (cut 5 points for each error) : 15.

(*d*) Target effect: 50.

(3) *Exercise 6.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 5.

(*c*) Correct procedure and technique of fire (cut 5 points for each error) : 15.

(*d*) Target effect: 50.

(4) *Exercise 7.*

(*a*) Completing exercise within time limit: 20.

(*b*) Correct procedure and technique of fire (cut 5 points for each error) : 15.

(*c*) Target effect: 50.

e. The exercises are conducted as follows after the tank crew has been ordered to move out:

(1) *Exercise 1 (moving tank).* The moving tank target is released. The tank is halted and the target is engaged with the main gun using battlesight. The exercise must be completed within 35 seconds. Time starts on the command to halt the tank. When the exercise is completed, the tank moves out.

(2) *Exercise 2 (moving truck).* The moving truck target is released. The tank is halted and the target is engaged with the coaxial machinegun using battlesight. The exercise must be completed within 55 seconds. Time starts on the command to halt the tank. When the exercise is completed, the tank moves out.

(3) *Exercise 3 (antitank).* The target appears. The tank is halted and the target is engaged with the main gun. The exercise must be completed within 45 seconds. Time starts on the command to halt the tank. When the exercise is completed, the tank moves out.

(4) *Exercise 4 (stationary tank).* The target appears and the tank is halted. The tank commander engages the target with the main gun using his direct-fire sight. The exercise must be completed within 45 seconds.

Time starts on the command to halt the tank. When the exercise is completed, the tank moves out.

(5) *Exercise 5 (troops)*. The targets appear and are engaged with the coaxial machinegun while continuing to move. The exercise must be completed within 55 seconds. Time starts when the tank commander identifies the target area.

(6) *Exercise 6 (antitank)*. The target appears and the tank is halted. The target is engaged with the caliber .50 machinegun. The exercise must be completed within 1 minute. Time starts on the command to halt the tank. When the exercise is completed, the tank moves out.

(7) *Exercise 7 (suspected area)*. The caliber .50 machinegun is reloaded, if necessary, and the examiner designates a suspected area and the tank commander reconnoiters by fire, using the caliber .50 machinegun while the tank is moving. The exercise must be completed within 1 minute. Time starts when the tank commander identifies the target area.

f. Control Measures.

(1) The safety officer follows the firing tank in a radio-equipped vehicle.

(2) Radio communication will be maintained between the safety officer and the firing tank. An examiner will ride on the firing tank and have communication with the tank crew and safety officer.

(3) The firing tank should move at least 50 meters between exercises.

(4) Upon completion of the last exercise, all weapons are cleared.

g. Scoring.

(1) The examiner scores the tank crew from the firing tank, using a binocular to determine target hits or effect.

(2) Time for each exercise is determined by the examiner.

(3) The examiner will score the firing procedures of the tank crew.

(4) An appropriate scorecard is shown in figure 129.

263. Table VIIB—Crew Field Firing Exercises (Night)

a. The purpose of these exercises is to develop the crew's ability to engage moving and stationary targets at night with all tank weapons.

UNIT ____________________ TANK CREW ____________________

COMMANDER ____________________

DATE ____________________ GUNNER ____________________

DRIVER ____________________

LOADER ____________________

SCORE CARD: TABLE VIIA—CREW FIELD FIRING EXERCISES (DAY) 700 POINTS POSSIBLE

EXERCISE	NUMBER OF ROUNDS	ITEM AND POSSIBLE POINTS		SCORE
1 Moving Tank	2 Main Gun	Completing within 35 seconds	30	______
		Target identification	5	______
		Fire commands and crew duties	20	______
		First-round hit	30	______
		Second-round hit	30	______
		TOTAL POSSIBLE	115	EXERCISE TOTAL
2 Moving Truck	50 Coax	Completing within 55 seconds	20	______
		Target identification	5	______
		Fire commands, crew duties, and technique of fire	15	______
		Target effect	50	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
3 Antitank	2 Main Gun	Completing within 45 seconds	30	______
		Target identification	5	______
		Fire commands and crew duties	20	______
		First-round hit	30	______
		Second-round hit	30	______
		TOTAL POSSIBLE	115	EXERCISE TOTAL
4 Tank	2 Main Gun	Completing within 45 seconds	30	______
		Target identification	5	______
		Fire commands and crew duties	20	______
		First-round hit	30	______
		Second-round hit	30	______
		TOTAL POSSIBLE	115	EXERCISE TOTAL
5 Troops	50 Coax	Completing within 55 seconds	20	______
		Target identification	5	______
		Fire commands, crew duties, and technique of fire	15	______
		Target effect	50	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
6 Antitank	50 Cal .50	Completing within 1 minute	20	______
		Target identification	5	______
		Procedure and technique of fire	15	______
		Target effect	50	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
7 Suspected Area	50 Cal .50	Completing within 1 minute	20	______
		Procedure and technique of fire	15	______
		Target effect	50	______
		TOTAL POSSIBLE	85	EXERCISE TOTAL
		TOTAL SCORE		

Minimum Satisfactory Score .... 490 points.

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EXAMINER OFFICER IN CHARGE

Figure 129. Scorecard for table VIIA.

b. A battlesight of 1,000 meters (yards) and the appropriate type ammunition is indexed. Ammunition is stowed and communication is established with the safety officer. A searchlight-equipped tank accompanies the firing tank to provide illumination. An outline of the exercises is shown in table VIIB. Time for exercises 2 through 7 will start upon effective target illumination. The sequence may be varied to suit the available range facility and the same range may be used as was used for table VIIA.

c. Each crew will make a dry run of the exercise at night before making the first firing run. This can be done in conjunction with the firing run of another tank. On the dry run, the examiner will indicate the location of the targets and what each target represents, but he will not reveal the range to the targets or allow ranging on the targets on rangefinder-equipped tanks.

Table VIIB

Possible score: 700
Minimum satisfactory score: 420

Exercise	Weapon	Range in meters (yards)	No. of rounds	Target description	Method of illumination	Possible points
1	Main gun	1,500–2,000 (simulated for QE).	None	Troops (simulated) (range card).	None (range card).	85
2	Main gun	900–1,100	([a])2	Moving tank (6 x 6-ft. panel).	Tank searchlight.	115
3	Coax MG	600– 800	50	Moving truck (3 x 5-ft. panel).	Tank searchlight.	90
4	Coax MG	400– 800	100	Troops (10 E-type).	Tank searchlight.	90
5	Main gun	900–1,100	([b])2	Antitank (6 x 6-ft. panel).	Tank searchlight.	115
6	Cal .50 MG	1,000–1,200	50	Troops (10 E-type).	Tank searchlight.	90
7	Main gun	1,500–2,000	([a])2	Stationary tank (6 x 6-ft. panel).	3 illuminating shells.	115

[a] AP–T or TP–T.
[b] HE or HEP.

d. Points for each exercise are given as follows: (No partial credit except as indicated.)

(1) *Exercise 1.*

(*a*) Completing exercise within time limit: 30.

(*b*) Correct fire commands and crew duties (cut 5 points for each error) : 25.

(*c*) Accuracy of lay (15 points for elevation and 15 points for deflection, both within one mil) : 30.

(2) *Exercises 2, 5, and 7.*

(*a*) Completing exercise within time limit: 30.

(*b*) Identifying target without assistance of examiner: 5.

(*c*) Correct fire commands and crew duties (cut 5 points for each error) : 20.

(*d*) Each target hit: 30.

(3) *Exercises 3 and 4.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 5.

(*c*) Correct fire commands, crew duties, and technique of fire (cut 5 points for each error) : 15.

(*d*) Target effect: 50.

(4) *Exercise 6.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 5.

(*c*) Correct procedure and technique of fire (cut 5 points for each error) : 15.

(*d*) Target effect: 50.

e. The exercises are conducted as follows after the tank crew has been ordered to move out:

(1) *Exercise 1 (range card)*. The tank occupies a prepared position. A range card, prepared by examiner personnel, is given to the tank commander of the firing tank. The tank crew is required to simulate engaging a target with one round of ammunition, using range card data as designated by the examiner. The exercise must be completed within 1 minute and 30 seconds. Time starts with the gun laid on the aiming stakes and the azimuth indicator and gunner's aid zeroed. When the exercise is completed, the tank moves out.

(2) *Exercise 2 (moving tank)*. The moving tank target is illuminated by the searchlight tank, using continuous illumination. The firing tank is halted and the target is engaged with the main gun, using battlesight. The exercise must be completed within 45 seconds. The searchlight is turned off after the exercise is completed and the firing tank moves out.

(3) *Exercise 3 (moving truck).* The searchlight tank illuminates the moving target, using continuous illumination. The firing tank is halted and the target is engaged with the coaxial machinegun, using battlesight. The exercise must be completed within 1 minute. The searchlight is turned off after the exercise is completed and the firing tank moves out.

(4) *Exercise 4 (troops).* The searchlight tank illuminates the targets, using flicker illumination. The crew engages the targets with the coaxial machinegun while continuing to move. The exercise must be completed within 1 minute and 30 seconds.

(5) *Exercise 5 (antitank).* The searchlight tank illuminates the target, using flicker illumination. The firing tank is halted and the target is engaged with the main gun. The exercise must be completed within 1 minute. The searchlight is turned off after completing the exercise and the firing tank moves out.

(6) *Exercise 6 (troops).* The searchlight tank illuminates the targets, using flicker illumination. The firing tank is halted and the targets are engaged with the caliber .50 machinegun. The exercise must be completed within 1 minute and 15 seconds. The searchlight is turned off after completing the exercise and the firing tank moves out.

(7) *Exercise 7 (stationary tank).* The target is illuminated by three illuminating shells. The firing tank is halted and the target is engaged with the main gun. The exercise must be completed within 45 seconds.

f. Control Measures.

(1) The safety officer follows the firing tank in a radio-equipped vehicle.

(2) Radio communition will be maintained between the safety officer, searchlight tank, and firing tank. An examiner will ride on the firing tank and have communication with the tank crew and safety officer.

(3) The firing tank should move at least 50 meters between exercises.

(4) Upon completion of the last exercise, all weapons are cleared.

UNIT ______________

DATE ______________

TANK CREW ______________

COMMANDER ______________

GUNNER ______________

DRIVER ______________

LOADER ______________

SCORE CARD: TABLE VIIB—CREW FIELD FIRING EXERCISES (NIGHT)

700 POINTS POSSIBLE

EXERCISE	NUMBER OF ROUNDS	ITEM AND POSSIBLE POINTS		SCORE
1 Troops	None (range card)	Completing within 1 minute and 30 seconds	30	______
		Fire commands and crew duties	25	______
		Correct elevation (within 1 mil)	15	______
		Correct deflection (within 1 mil)	15	______
		TOTAL POSSIBLE	85	EXERCISE TOTAL
2 Moving Tank	2 Main Gun	Completing within 45 seconds	30	______
		Target identification	5	______
		Fire commands and crew duties	20	______
		First-round hit	30	______
		Second-round hit	30	______
		TOTAL POSSIBLE	115	EXERCISE TOTAL
3 Moving Truck	50 Coax	Completing within 1 minute	20	______
		Target identification	5	______
		Fire commands, crew duties, and technique of fire	15	______
		Target effect	50	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
4 Troops	100 Coax	Completing within 1 minute and 30 seconds	20	______
		Target identification	5	______
		Fire commands, crew duties, and technique of fire	15	______
		Target effect	50	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
5 Antitank	2 Main Gun	Completing within 1 minute	30	______
		Target identification	5	______
		Fire commands and crew duties	20	______
		First-round hit	30	______
		Second-round hit	30	______
		TOTAL POSSIBLE	115	EXERCISE TOTAL
6 Troops	50 Cal .50	Completing within 1 minute and 15 seconds	20	______
		Target identification	5	______
		Procedure and technique of fire	15	______
		Target effect	50	______
		TOTAL POSSIBLE	90	EXERCISE TOTAL
7 Tank	2 Main Gun	Completing within 45 seconds	30	______
		Target identification	5	______
		Fire commands and crew duties	20	______
		First-round hit	30	______
		Second-round hit	30	______
		TOTAL POSSIBLE	115	EXERCISE TOTAL
		TOTAL SCORE		

Minimum Satisfactory Score .... 420 points.

______________ EXAMINER

______________ OFFICER IN CHARGE

Figure 130. Scorecard for table VIIB.

g. Scoring.

(1) The examiner scores the tank crew from the firing tank, using a binocular to determine target hits or effect.

(2) Time for each exercise is determined by the examiner.

(3) The examiner will score the firing procedures of the tank crew.

(4) An appropriate scorecard is shown in figure 130.

264. Table VIIIA—Crew Proficiency Exercises (Day)

a. The purpose of these exercises is to test the crew's ability to engage moving and stationary targets with all tank weapons during daylight (fig. 140). This table, in conjunction with table VIIIB, is the basis for the crew classification; therefore, there should be no dry or practice runs.

b. The crew is required to move over unimproved terrain and engage a series of targets. The terrain should be different from that used for tables VIIA and VIIB; however, if range facilities are limited, the same terrain may be used with the route of movement and target locations varied. All firing crews are briefed on the conduct of the course and the tactical situation, including the mission of the tank crew. The briefing should include also information on what each type target represents. The sequence of the exercises may be varied to fit the available range facility. An outline of the exercises is shown in table VIIIA. Time for each exercise starts when the tank commander has located the target.

Table VIIIA

Possible score: 1,000
Minimum satisfactory score: 700

Exercise	Weapon	Range in meters (yards)	No. of rounds	Target description	Possible points
Zeroing.	Main gun	Zeroing range.	(b)2	Zeroing panel	None
1	Coax MG	200– 400	50	Troops (10 E-type)	100
2	Main gun	1,500–2,000	(b)2	Tank (6 x 6-ft. panel)	125
3	Cal .50 MG	1,000–1,200	50	Troops (10 E-type)	100
4	Coax MG	500– 600	100	Troops (10 E-type)	100
5	Main gun	900–1,100	(a)2	Antitank (3 x 5-ft. panel)	125
6	Main gun	900–1,100	(b)2	Moving tank (6 x 6-ft. panel)	125
7	Cal .50 MG	1,000–1,200	50	Truck (6 x 6-ft. panel)	100
8	Coax MG	500– 800	50	Moving truck (6 x 6-ft. panel).	100
9	Main gun	1,500–2,000	(c)2	House (6 x 6-ft. panel)	125

[a] HE or HEP.
[b] AP–T or TP–T.
[c] WP, HE, or HEP.

c. Points for each exercise are given as follows: (No partial credit except as indicated.)

(1) *Exercises 1 and 4.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 15.

(*c*) Correct fire commands, crew duties, and technique of fire (cut 5 points for each error): 15.

(*d*) Each target that is hit (up to a maximum of 5 targets): 10.

(2) *Exercises 2, 5, 6, and 9.*

(*a*) Completing exercise within time limit: 30.

(*b*) Identifying target without assistance of examiner: 15.

(*c*) Correct fire commands and crew duties (cut 5 points for each error): 20.

(*d*) Each target hit: 30.

(3) *Exercise 3.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 15.

(*c*) Correct procedure and technique of fire (cut 5 points for each error): 15.

(*d*) Each target that is hit (up to a maximum of 5 targets): 10.

(4) *Exercise 7.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 15.

(*c*) Correct procedure and technique of fire (cut 5 points for each error): 15.

(*d*) Each hit on the target (up to a maximum of 5 hits): 10.

(5) *Exercise 8.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 15.

(*c*) Correct fire commands, crew duties, and technique of fire (cut 5 points for each error): 15.

(*d*) Each hit on the target (up to a maximum of 5 hits): 10.

d. The exercises are conducted as follows after the tank crew has been ordered to move out:

(1) *Exercise 1 (troops)*. The tank commander observes the targets. The tank crew engages the targets with the coaxial machinegun while moving. The exercise must be completed within 55 seconds.

(2) *Exercise 2 (tank)*. The tank commander observes the

target. The tank is halted and the target is engaged with the main gun. The exercise must be completed within 45 seconds. After completing the exercise, the tank moves out.

(3) *Exercise 3 (troops)*. The tank commander observes the targets, the tank is halted, and the targets are engaged with the caliber .50 machinegun. The exercise must be completed within 1 minute. After completing the exercise, the tank moves out.

(4) *Exercise 4 (troops)*. The tank commander observes the targets. The tank crew engages the targets with the coaxial machinegun while moving. The exercise must be completed within 1 minute and 15 seconds.

(5) *Exercise 5 (antitank)*. The tank commander observes the target. The tank is halted and the target is engaged with the main gun. The exercise must be completed within 35 seconds. After completing the exercise, the tank moves out.

(6) *Exercise 6 (moving tank)*. The tank commander observes the target. The tank is halted and the crew engages the target with the main gun. The exercise must be completed within 35 seconds. After completing the exercise, the tank moves out.

(7) *Exercise 7 (stationary vehicle)*. The tank commander observes the target. The tank is halted and the tank commander engages the target with the caliber .50 machinegun. The exercise must be completed within 1 minute. After completing the exercise, the tank moves out.

(8) *Exercise 8 (moving truck)*. The tank commander observes the target. The tank is halted and the crew engages this target with the coaxial machinegun. The exercise must be completed within 55 seconds. After completing the exercise, the tank moves out.

(9) *Exercise 9 (house)*. The tank commander observes the target. The tank is halted and the target is engaged with the main gun. The exercise must be completed within 45 seconds.

e. Control measures are the same as for table VIIA.

f. All targets should be surprise targets; i.e., their location is not known by the crew being tested and only one target is in view at one time. Depending on the materials available, they should be activated by demolitions, by being moved into view, by pop-up

UNIT ______________________ TANK CREW ______________________

DATE ______________________ COMMANDER ______________________

GUNNER ______________________

DRIVER ______________________

LOADER ______________________

SCORE CARD: TABLE VIIIA—CREW PROFICIENCY EXERCISES (DAY) 1,000 POINTS POSSIBLE

EXERCISE	NUMBER OF ROUNDS	ITEM AND POSSIBLE POINTS		SCORE
1 Troops	50 Coax	Completing within 55 seconds	20	____
		Target identification	15	____
		Fire commands, crew duties, and technique of fire	15	____
		Each target that is hit (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL ____
2 Tank	2 Main Gun	Completing within 45 seconds	30	____
		Target identification	15	____
		Fire commands and crew duties	20	____
		First-round hit	30	____
		Second-round hit	30	____
		TOTAL POSSIBLE	125	EXERCISE TOTAL ____
3 Troops	50 Cal .50	Completing within 1 minute	20	____
		Target identification	15	____
		Procedure and technique of fire	15	____
		Each target that is hit (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL ____
4 Troops	100 Coax	Completing within 1 minute and 15 seconds	20	____
		Target identification	15	____
		Fire commands, crew duties, and technique of fire	15	____
		Each target that is hit (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL ____
5 Antitank	2 Main Gun	Completing within 35 seconds	30	____
		Target identification	15	____
		Fire commands and crew duties	20	____
		First-round hit	30	____
		Second-round hit	30	____
		TOTAL POSSIBLE	125	EXERCISE TOTAL ____
6 Moving Tank	2 Main Gun	Completing within 35 seconds	30	____
		Target identification	15	____
		Fire commands and crew duties	20	____
		First-round hit	30	____
		Second-round hit	30	____
		TOTAL POSSIBLE	125	EXERCISE TOTAL ____
7 Truck	50 Cal .50	Completing within 1 minute	20	____
		Target identification	15	____
		Procedure and technique of fire	15	____
		Each hit on target (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL ____
8 Moving Truck	50 Coax	Completing within 55 seconds	20	____
		Target identification	15	____
		Fire commands, crew duties, and technique of fire	15	____
		Each hit on the target (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL ____
9 House	2 Main Gun	Completing within 45 seconds	30	____
		Target identification	15	____
		Fire commands and crew duties	20	____
		First-round hit	30	____
		Second-round hit	30	____
		TOTAL POSSIBLE	125	EXERCISE TOTAL ____
			TOTAL SCORE	

Minimum Satisfactory Score .... 700 points.

______________________ EXAMINER ______________________ OFFICER IN CHARGE

Figure 131. Scorecard for table VIIIA.

techniques, by being hidden by terrain features until the firing tank reaches a certain position on the course, or by a combination of these methods. The targets should be quite obvious, but if a crew fails to locate a target within 25 meters after it moves into view, the examiner should point it out and deduct the required number of points.

g. Scoring will be as follows:

(1) Scoring personnel will score all targets. However, if tank hulls or other metal targets are used for main gun exercises, the examiner will score these target hits.

(2) Time for each exercise is determined by the examiner.

(3) The examiner will score the firing procedures of the tank crew.

(4) An appropriate scorecard is shown in figure 131.

265. Table VIIIB—Crew Proficiency Exercises (Night)

a. The purpose of these exercises is to test the crew's ability to engage moving and stationary targets with all tank weapons at night. This table, in conjunction with table VIIIA, is the basis for the crew classification; therefore, there is no dry or practice run. The same range may be used as was used for table VIIIA.

b. The crew is required to move over unimproved terrain and engage a series of illuminated targets. A tank-mounted searchlight, hand-held or rifle flare, and mortar or artillery shells are used for target illumination. All firing crews are briefed on the conduct of the course and the tactical situation, including the mission of the tank crew. The briefing also should include information on what each type target represents and on illuminating procedures. The sequence of the exercises may be varied to fit existing range facilities. An outline of the exercises is shown in table VIIIB. Time for each problem starts when the targets have been effectively illuminated.

Table VIIIB

Possible score: 1,000
Minimum satisfactory score: 600

Exercise	Weapon	Range in meters (yards)	No. of rounds	Target description	Method of illumination	Possible points
1	Coax MG	200– 400	50	Troops (10 E-type).	Flare	100
2	Main gun	900–1,000	(b)2	Tank (6 x 6-ft. panel).	Tank searchlight.	125
3	Cal .50 MG	1,000–1,300	50	Troops (10 E-type).	Tank searchlight.	100

Table VIIIB—Continued

Possible score: 1,000
Minimum satisfactory score: 600

Exercise	Weapon	Range in meters (yards)	No. of rounds	Target description	Method of illumination	Possible points
4	Coax MG	400– 600	100	Troops (10 E-type).	Tank searchlight.	100
5	Main gun	1,400–1,600	(a)2	Antitank (6 x 6-ft. panel).	3 illuminating shells.	125
6	Main gun	900–1,100	(b)2	Moving tank (6 x 6-ft. panel).	Tank searchlight.	125
7	Cal .50 MG	800–1,000	50	Truck (6 x 6-ft. panel).	Tank searchlight.	100
8	Coax MG	600– 800	50	Moving truck (6 x 6-ft. panel).	Tank searchlight.	100
9	Main gun	1,200–1,400	(a)2	Antitank (6 x 6-ft. panel).	Tank searchlight.	125

[a] HE or HEP.
[b] AP–T or TP–T.

c. Points for each exercise are given as follows: (No partial credit except as indicated.)

(1) *Exercises 1 and 4.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 15.

(*c*) Correct fire commands, crew duties, and technique of fire (cut 5 points for each error): 15.

(*d*) Each target that is hit (up to a maximum of 5 targets): 10.

(2) *Exercises 2, 5, 6, and 9.*

(*a*) Completing exercise within time limit: 30.

(*b*) Identifying target without assistance of examiner: 15.

(*c*) Correct fire commands and crew duties (cut 5 points for each error): 20.

(*d*) Each target hit: 30.

(3) *Exercise 3.*

(*a*) Completing exercise within time limit: 20.

(*b*) Identifying target without assistance of examiner: 15.

(*c*) Correct procedure and technique of fire (cut 5 points for each error): 15.

(*d*) Each target that is hit (up to a maximum of 5 hits): 10.

(4) *Exercise 7.*

(*a*) Completing exercise within time limit: 20.

(b) Identifying target without assistance of examiner: 15.

(c) Correct procedure and technique of fire (cut 5 points for each error) : 15.

(d) Each hit on the target (up to a maximum of 5 hits) : 10.

(5) *Exercise 8.*

(a) Completing exercise within time limit: 20.

(b) Identifying target without assistance of examiner: 15.

(c) Correct fire commands, crew duties, and technique of fire (cut 5 points for each error) : 15.

(d) Each hit on the target (up to a maximum of 5 hits) : 10.

d. The exercises are conducted as follows after the tank crew has been ordered to move out:

(1) *Exercise 1 (troops).* A flare is fired to mark and illuminate the target area. The tank crew engages the targets with the coaxial machinegun while moving. The exercise must be completed within 1 minute.

(2) *Exercise 2 (tank).* The searchlight illuminates the target with flicker illumination and the firing tank is halted. The crew engages the target with the main gun. The exercise must be completed within 1 minute. After the exercise is completed, the tank moves out.

(3) *Exercise 3 (troops).* The searchlight illuminates the targets with flicker illumination and the firing tank halts. The tank commander engages the targets with the caliber .50 machinegun. The exercise must be completed within 1 minute and 15 seconds. After the exercise is completed, the tank moves out.

(4) *Exercise 4 (troops).* The searchlight illuminates the targets with flicker illumination and the tank crew engages the targets with the coaxial machinegun while continuing to move. The exercise must be completed within 1 minute and 30 seconds.

(5) *Exercise 5 (antitank).* The target is illuminated by three illuminating shells. The firing tank is halted and the crew engages the target with the main gun. The exercise must be completed within 45 seconds. After completing the exercise, the tank moves out.

(6) *Exercise 6 (moving tank).* The tank searchlight illuminates the moving tank target using continuous illumination. The firing tank is halted and the crew engages the target with the main gun. The exercise must be com-

UNIT ______________________ TANK CREW ______________

DATE ______________________

COMMANDER ______________

GUNNER ______________

DRIVER ______________

LOADER ______________

SCORE CARD: TABLE VIIIB—CREW PROFICIENCY EXERCISES (NIGHT) — 1,000 POINTS POSSIBLE

EXERCISE	NUMBER OF ROUNDS	ITEM AND POSSIBLE POINTS		SCORE
1 Troops	50 Coax	Completing within 1 minute	20	____
		Target identification	15	____
		Fire commands, crew duties, and technique of fire	15	____
		Each target that is hit (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL
2 Tank	2 Main Gun	Completing within 1 minute	30	____
		Target identification	15	____
		Fire commands and crew duties	20	____
		First-round hit	30	____
		Second-round hit	30	____
		TOTAL POSSIBLE	125	EXERCISE TOTAL
3 Troops	50 Cal .50	Completing within 1 minute and 15 seconds	20	____
		Target identification	15	____
		Procedure and technique of fire	15	____
		Each target that is hit (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL
4 Troops	100 Coax	Completing within 1 minute and 30 seconds	20	____
		Target identification	15	____
		Fire commands, crew duties, and technique of fire	15	____
		Each target that is hit (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL
5 Antitank	2 Main Gun	Completing within 45 seconds	30	____
		Target identification	15	____
		Fire commands and crew duties	20	____
		First-round hit	30	____
		Second-round hit	30	____
		TOTAL POSSIBLE	125	EXERCISE TOTAL
6 Moving Tank	2 Main Gun	Completing within 45 seconds	30	____
		Target identification	15	____
		Fire commands and crew duties	20	____
		First-round hit	30	____
		Second-round hit	30	____
		TOTAL POSSIBLE	125	EXERCISE TOTAL
7 Truck	50 Cal .50	Completing within 1 minute and 15 seconds	20	____
		Target identification	15	____
		Procedure and technique	15	____
		Each hit on the target (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL
8 Moving Truck	50 Coax	Completing within 1 minute	20	____
		Target identification	15	____
		Fire commands, crew duties, and technique of fire	15	____
		Each hit on the target (max 5)	10	____
		TOTAL POSSIBLE	100	EXERCISE TOTAL
9 Antitank	2 Main Gun	Completing within 1 minute	30	____
		Target identification	15	____
		Fire commands and crew duties	20	____
		First-round hit	30	____
		Second-round hit	30	____
		TOTAL POSSIBLE	125	EXERCISE TOTAL
		TOTAL SCORE		

Minimum Satisfactory Score .... 600 points.

______________________ EXAMINER

______________________ OFFICER IN CHARGE

Figure 132. Scorecard for table VIIIB.

pleted within 45 seconds. After completing the exercise, the tank moves out.

(7) *Exercise 7 (truck)*. The searchlight illuminates the target with flicker illumination. The firing tank is halted and the tank commander engages the target with the caliber .50 machinegun. The exercise must be completed within 1 minute and 15 seconds. After completing the exercise, the tank moves out.

(8) *Exercise 8 (moving truck)*. The tank searchlight illuminates the moving truck target with continuous illumination. The firing tank is halted and the crew engages the target with the coaxial machinegun. The exercise must be completed within 1 minute. After completing the exercise, the tank moves out.

(9) *Exercise 9 (antitank)*. The tank searchlight illuminates the target with flicker illumination. The firing tank is halted and the crew engages the target with the main gun. The exercise must be completed within 1 minute.

e. Control measures are the same for table VIIB.

f. Scoring will be as follows:

(1) Scoring personnel will score all targets. However, if tank hulls or other metal targets are used for the main gun exercises, the examiner will score these target hits.

(2) An examiner on each firing tank will score the firing procedures of the tank crew.

(3) Time for each exercise is determined by the examiner.

(4) An appropriate scorecard is shown in figure 132.

Section VII. FAMILIARIZATION FIRING

266. General

a. Tank gunnery familiarization firing is performed by personnel assigned to armor units, *other than tank crewmen,* who are required by AR 370–5 to fire a familiarization course annually. The objective of a familiarization course is to give these personnel training in the application of fundamentals in the conduct of direct fire. A familiarization course does not qualify them as gunners and it does not replace qualification firing.

b. Before personnel are permitted to fire the familiarization course, a minimum of 24 hours of preliminary instruction should be given covering the following subjects:

(1) Weapons mechanical training: 6 hours.

(2) Turret familiarization: 8 hours.
(3) Conduct of fire (direct fire only): 4 hours.
(4) Nonfiring exercises, including sight adjustment, direct laying, adjustment of fire, crew drill, manipulation exercises, tracking and leading exercises, and gun drill: 4 hours.
(5) Tank crewman preliminary gunnery examination: 2 hours.

Note. The preliminary gunnery examination must be successfully completed by personnel prior to participating in firing exercises (pars. 237–252).

c. Familiarization firing consists of firing tables IX and X. Timing and scoring is maintained for instruction and information only.

d. Ammunition required to fire one individual through the familiarization tables is shown in the following chart.

Table	Ammunition				
	Coaxial machinegun		Cal .50	Main gun	
	Tracer, MLB	4–1. MLB	4–1 MLB	HE or HEP	AP–T or TP–T
IX([a])	40				
X([b])		100	50	2	2
Total	40	100	50	2	2

[a] Includes 5 additional rounds for each gunner who must rezero, 5 additional rounds for examiner to zero on the moving target, and 6 additional rounds to compensate for multiple round burst due to malfunctions of the single-shot device. The most recently packed standard coaxial machinegun tracer ammunition available will be used. Frangible ammunition may be substituted for tracer when only limited range facilities are available.

[b] Five rounds of AP–T or TP–T per tank will be required to establish the zero of the tank gun, if it has not previously been established. Seventy-five rounds of coaxial machinegun and 10 rounds of caliber .50 machinegun ammunition will be required per tank for zeroing.

267. Table IX—Subcaliber Familiarization Exercises

a. The purpose of these exercises is to familiarize personnel with laying and firing the tank gun with a correct sight picture and adjusting fire by sensing methods before firing service ammunition.

b. In these exercises, the individual, as gunner, first zeroes the primary sight and secondary sight with the coaxial machinegun. He then fires 5 first-round-hit exercises, 5 sensing adjustment exercises, and 3 moving target exercises.

c. Scoring circles, aiming crosses, and tank silhouettes can be drawn on almost any type of target currently in use. In the first-round-hit and sensing adjustment exercises, the individual fires at two silhouettes or panels on each of which are 5 consecutively numbered circle-type targets, each target consisting of a 4-inch circle and an 8-inch circle. In the moving target exercises, the individual fires at 6 x 8-inch silhouettes drawn on a panel, which moves at a constant speed of approximately 3 miles per hour.

d. In the zeroing procedure, the individual boresights the gun and adjusts the sights on any target of the zeroing silhouette at 60 meters. The periscope is adjusted with the zeroing range for the tank and the appropriate type ammunition indexed into the fire control system. The secondary sight is adjusted with the boresight cross on the boresight point. The individual fires a three-round shot group at the boresight point, re-laying for each round with the same sight picture. He then unlocks the boresight knobs on the primary sight, refers the aiming cross to the center of the shot group, locks the knobs, and fires a check round. It must hit within the 4-inch circle. If it does not, the zeroing procedure is repeated. When zeroing has been accomplished, the gunner unlocks the azimuth and elevation knobs of the telescope, lays the appropriate point of the reticle (range line or cross) on the aiming point, and locks the boresight knobs. (When the examiner checks this sight, he should induce a range error of plus or minus 200 to prepare this sight for the adjustment exercise. He also should refer the reticle in his direct-fire sight to the aiming point for use in checking the gunner's actions.) There is no score for this part of the exercise; however, accuracy has a distinct bearing on the remainder of table IX.

e. In the first-round-hit exercises, the individual, using the primary direct-fire sight, the zero that he established in the zeroing exercise, and either power or manual controls, fires 5 exercises of 1 round each, 1 at each target on the silhouette. Before firing, he lays on the zeroing target. At the command COMMENCE FIRING, he traverses to the first target on the silhouette. For example, he would fire at target 1, then at target 2, continuing in this manner until he has fired at all 5 targets. The emphasis is on speed and accuracy. If the gunner uses the correct zero and sight picture, he should obtain a hit within the 4-inch circle of each target. He should complete the 5 exercises in 25 seconds.

f. Sensing adjustment exercise are conducted as follows:

(1) *Primary method of sensing adjustment (primary sights) (targets 1–3).* Without disturbing the zero of the primary sight, the examiner induces a range error of plus or minus 200 by indexing in the rangefinder or by announcement in the fire command on tanks not equipped

with a rangefinder. This range error, which should be varied, will cause the gunner to miss with the first round. The examiner announces an initial fire command for each engagement, giving the target number for the description element. The individual fires, notes the point on the sight reticle where the tracer appeared in relation to the target, applies the primary method of sensing adjustment, and fires the second round. He should obtain a second-round hit in the 4-inch circle. The gunner is timed from the command FIRE of the initial fire command. He has 10 seconds to complete the exercise.

(2) *Primary method of sensing adjustment* (*secondary sight*) (*target 4*). To make the individual miss the 4-inch circle with the first round, the instructor induces a range error of plus or minus 200 when he checks the sight for the correct zeroing procedure. He then announces an initial fire command with the zeroing range as the range element. The individual fires, notes where the tracer appeared in relation to the target, and, using the reticle in the secondary sight, applies the primary method of sensing adjustment and fires the second round. He should obtain a second-round hit in the 4-inch circle. The individual is timed from the command FIRE of the initial fire command. He has 10 seconds to complete the exercise.

Note. During the engagement of targets 1–4, if the crewman cannot see the strike of the initial round, he announces LOST, at which time the examiner announces LOST, FIRE. The individual fires a second round without adjusting and then fires a third round using the primary method of sensing adjustment. The third round is scored. The time for the complete exercise is not changed.

(3) *Alternate method of sensing adjustment* (*primary sight*) (*target 5*). Without disturbing the zero of the primary sight, the examiner indexes an incorrect range in the rangefinder or announces an incorrect range in the initial fire command on tanks not equipped with a rangefinder. The individual lays on the target, announces ON THE WAY, simulates firing, and announces LOST. The examiner announces a range sensing and issues a subsequent fire command to correct the range error. The individual applies the correction, using the sight reticle, and fires. If a hit is not obtained in the 4-inch circle with the first round, the individual applies the primary method of sensing adjustment and fires a second round.

The individual is timed from the command FIRE of the subsequent fire command. He has 10 seconds to complete the firing.

g. When a moving target is initially engaged, proper procedure is for the gunner to apply one lead. In this exercise, however, a normal lead of five mils is too long because of the low speed of the target; therefore, the examiner introduces an error of ½-lead into the sight in order for a 1-lead sight picture to hit the target. After firing a check round at a stationary target to insure that the zero of each sight is correct for the zeroing range, the examiner creates a false half-lead in each sight by moving the reticle to the left ½-lead (2½ mils) if the target is to move from right to left, and to the right if the target is to move from left to right. The examiner then fires a check round at a zeroing target on the moving panel, using one lead. He adjusts the sights, if necessary, until he is able to hit within 2 inches of the center of the target with a 1-lead sight picture. Firing exercises are conducted in the direction for which the false lead was induced only. When the target is moving in the opposite direction, tracking practice is conducted.

(1) *Primary sight exercises.* For the first two moving target exercises, the examiner indexes (announces on tanks not equipped with a rangefinder) the zeroing range. The individual fires three rounds in each exercise, using the primary sight and the primary method of sensing adjustment, if necessary. The manual controls are used for the first exercise and the power controls for the second. From the initial command FIRE, 15 seconds are allowed for each exercise. All rounds are scored.

(2) *Secondary sight exercise.* For the third moving target exercise, the examiner announces the zeroing range in his initial fire command. The individual uses the secondary sight and power controls. The exercise is fired, timed, and scored in the same manner as are the other moving target exercises.

Note. If the individual cannot sense a round, he will announce LOST, the examiner will announce LOST, FIRE, and the individual will complete the exercise. No additional rounds or time are allowed.

h. Exercises are scored as shown in table IX.

Table IX

Possible score: 160

Exercise	No. of rounds[a]	Sight	Method of sensing adjustment	Controls	Scoring[b]	
Zeroing	5	Primary & secondary	(Zeroing)	Manual		None
1	1	Primary	(First-round-hit)	Manual or power	10	Each hit in 4-inch circle, 10 points. Each hit in 8-inch circle, 5 points.
2	1	Primary	(First-round-hit)	Manual or power	10	
3	1	Primary	(First-round-hit)	Manual or power	10	
4	1	Primary	(First-round-hit)	Manual or power	10	
5	1	Primary	(First-round-hit)	Manual or power	10	
6	2	Primary	Primary	Manual	10	Second-round hit in 4-inch circle, 10 points. Second-round hit in 8-inch circle, 5 points.
7	2	Primary	Primary	Manual	10	
8	2	Primary	Primary	Manual	10	
9	2	Secondary	Primary	Manual	10	
10	2	Primary	Alternate	Manual	10	First-round hit in 4-inch circle, 10 points. Second-round hit in 4-inch circle, 5 points.
11	3	Primary	Primary	Manual	20	Each hit, 5 points. Correct tracking, 5 points.
12	3	Primary	Primary	Power	20	
13	3	Secondary	Primary	Power	20	

[a] See paragraph 266*d* for total ammunition allocations.

[b] No score for rounds fired after the time limit for each exercise.

i. See figure 133 for illustration of appropriate scorecard.

268. Table X—Service Familiarization Firing

a. These exercises are designed to familiarize the individual with the methods and procedure involved in firing tank weapons at stationary targets. Firing commences from the established zero for the main gun. Examiner personnel zero the machineguns before service familiarization exercises.

UNIT ____________ NAME ____________

DATE ____________ GRADE ____________ SN ____________

SCORE CARD: TABLE IX—SUBCALIBER FAMILIARIZATION EXERCISES • 160 POINTS POSSIBLE

EXERCISE	NUMBER OF ROUNDS	POSSIBLE	CORRECT TRACKING	1ST-RD HIT	2D-RD HIT	3D-RD HIT	SCORE
1	1	10					
2	1	10					
3	1	10					
4	1	10					
5	1	10					
6	2	10					
7	2	10					
8	2	10					
9	2	10					
10	2	10					
11	3	20					
12	3	20					
13	3	20					
						TOTAL SCORE	

Notes.

1. No score for rounds fired after following time limits:
   Exercises 1 through 5: 1 minute from initial command FIRE.
   Exercises 6, 7, 8, and 9: 10 seconds from initial command FIRE.
   Exercise 10: 10 seconds from command FIRE of subsequent fire command.
   Exercises 11, 12, and 13: 15 seconds from initial command FIRE.
2. Five points for correct tracking in exercises 11, 12, and 13 (included in exercise possible of 20).
3. For first round in exercises 1-5 and for second round in exercises 6-9: 10 points for hit in 4-inch circle and 5 points in 8-inch circle.
4. In exercise 10: 10 points for first-round hit in 4-inch circle and 5 points for second-round hit in 4-inch circle.
5. Five points for each hit in exercises 11, 12, and 13.

____________ EXAMINER ____________ OFFICER IN CHARGE

Figure 133. Scorecard for table IX.

b. The exercises are conducted as follows:

(1) *First-round-hit (primary sight)*. The examiner issues an initial fire command and indexes (announces on tanks not equipped with a rangefinder) the correct range. The individual engages the target with one round. He should obtain a first-round hit and complete the exercise within 10 seconds.

(2) *First-round-hit exercise (secondary sight)*. Fired and timed in the same manner as in the first exercise except that the range is announced and the secondary sight is used.

(3) *Primary method of sensing adjustment exercise.* The examiner issues an initial fire command and induces a 200-meter (-yard) range error into the rangefinder or announces an erroneous range on tanks not equipped with a rangefinder. The individual lays and fires two rounds, adjusting by the primary method of sensing adjustment if possible. The exercise should be completed within 20 seconds.

Note. The second round is fired even though a first-round hit is obtained. If the individual is unable to sense the first round, he will announce LOST, and the examiner will announce his range sensing and subsequent fire command. The individual will then fire the second round, using the alternate method of sensing adjustment. No additional time is allowed.

(4) *Coaxial machinegun exercise.* The examiner issues an initial fire command and the individual engages the target with the coaxial machinegun and adjusts the fire by observation of the tracer stream. The exercise should be completed within 1 minute.

(5) *Caliber .50 machinegun exercise.* The examiner designates the target. The individual loads the caliber .50 machinegun and engages the target, adjusting fire by observation of the tracer stream. The exercise should be completed within 2 minutes.

c. The exercises are scored as shown in table X.

Table X

Possible score: 125

Exercise	Target	Range in meters (yards)	No. of rounds	Sight	Method of sensing adjustment	Possible points
1	6 x 6-ft. panel	1,400–1,600	([a])1	Primary	(First-round hit.)	25
2	6 x 6-ft. panel	1,400–1,600	([a])1	Secondary	(First-round hit.)	25
3	3 x 5-ft. panel	1,200–1,400	([b])2	Primary	Primary	25
4	10 E-type	500– 800	([c])100	Infinity ([e])	Primary	25
5	10 E-type	1,000–1,200	([d])50	Cal .50	Primary	25

[a] AP–T or TP–T.
[b] HE or HEP.
[c] Coaxial machinegun, 4–1, MLB.
[d] Caliber .50 machinegun, 4–1, MLB.
[e] Primary sight is used on tanks not equipped with separate coaxial machinegun sight.

d. Points for each exercise are given as follows:

(1) *Exercise 1 and 2.*

(*a*) Completing exercise within 10 seconds of the initial command FIRE: 10.

UNIT ____________________ NAME ____________________

DATE ____________________ GRADE ______________ SN ______________

SCORE CARD: TABLE X—SERVICE FAMILIARIZATION FIRING

125 POINTS POSSIBLE

EXERCISE	POSSIBLE	COMPLETED IN TIME LIMIT	1ST-RD HIT OR TGT EFFECT	2D-RD HIT	CORRECT TECHNIQUE	SCORE
1						
2						
3						
4						
5						
					TOTAL SCORE	

Notes.

1. Ten points for completing in following time limits:
   Exercises 1 and 2: 10 seconds from initial command FIRE.
   Exercise 3: 20 seconds from initial command FIRE.
   Five points for completing in following time limits:
   Exercise 4: 1 minute from initial command FIRE.
   Exercise 5: 2 minutes from target identification.
2. Fifteen points for first-round hit in exercises 1 and 2 and for effective target coverage in exercises 4 and 5.
3. Fifteen points for second-round hit in exercise 3.
4. Five points for correct technique of adjustment in exercises 4 and 5.

____________________ EXAMINER

____________________ OFFICER IN CHARGE

Figure 134. Scorecard for table X.

(*b*) *Target hit: 15.*

(2) *Exercise 3.*

(*a*) Completing exercise within 20 seconds of the initial command FIRE: 10.

(*b*) Target hit with second round: 15.

(3) *Exercise 4.*

(*a*) Completing exercise within 1 minute of the initial command FIRE: 5.

(*b*) Correct technique of adjustment: 5.

(*c*) Effective target coverage: 15.

(4) *Exercise 5.*

(*a*) Completing exercise within 2 minutes of target identification: 5.

(*b*) Correct technique of adjustment: 5.

(*c*) Effective target coverage: 15.

e. See figure 134 for illustration of appropriate scorecard.

Section VIII. PRACTICE FIRING

269. General

a. Tank gunnery practice firing is performed by personnel who have a current classification in tank gunnery as a result of firing the qualification course. The objective of a practice course is to maintain and improve the gunnery proficiency that has been attained. A practice course does not requalify an individual or take the place of qualification firing. Practice firing should be conducted at least once annually and, preferably, every training quarter except the quarter when the qualification course is conducted.

b. Crewmen who are eligible to participate in practice firing may do so with no additional training except that considered necessary by the unit commander.

270. Practice Firing Exercises

Practice firing consists of firing any or all of the tables in the qualification course (pars. 234–265) either as written or as modified by the unit commander. A practice course is devised on the basis of the needs of the unit and range facilities, training time, and ammunition available. Scoring and timing are for instruction and information only. At least one-third of all practice firing should be conducted at night.

CHAPTER 12
ESTABLISHING AND CONDUCTING TANK FIRING RANGES

Section I. INTRODUCTION

271. General

a. Range firing is the type of training that most closely approximates the ultimate in combat—the destruction of the enemy. Realistic training is achieved by the use of live ammunition on organized ranges. Tank ranges are of various types. Some are permanent, such as those at armor training centers, while others are temporary. Range sites are designed for specific purposes, types of weapons, and particular firing exercises.

b. To accomplish a range firing mission, commanders must understand and comply with the appropriate provisions of AR 385–63, technical manuals and field manuals concerning weapons and ammunition, local range regulations, and unit SOP's.

272. Purpose

The purpose of this chapter is to—

a. Provide procedures and guidance for establishing and conducting tank firing ranges.

b. Supplement other publications by providing additional information and safety measures to be used in the conduct of tank firing ranges.

Section II. ESTABLISHING TANK FIRING RANGES

273. General

It is important that adequate facilities be made available for all individual and crew firing exercises. The area required for establishing a range for firing tank guns is dependent upon the caliber of the weapons, the types of ammunition to be used, and the exercises to be conducted.

274. Permanent Tank Firing Ranges

A permanently established tank firing range is one that has been designated a post facility and for which there is a surface danger area diagram designating a firing line or area and safety limits, both on a map of the area and on the ground. Each range is designed for specific purposes, types of weapons and ammunition, and particular firing exercises; it cannot be used for other types of firing unless approved by competent authority. Requests to use such facilities must include the information required by post range regulations. Commanders or instructors in charge of firing must be familiar with the established surface danger area diagram for the range.

275. Temporary Tank Firing Ranges

A temporary tank firing range is one that has been approved for a particular tank firing exercise and, because of limited use or interference with other ranges, has not been established as a permanent range. These ranges also are designed for specific purposes, types of weapons and ammunition, and particular firing exercises, but not permanently. Requests to establish and use a temporary tank firing range (unlike permanent ranges) normally must be accompanied by a surface danger area diagram to inform range personnel of the specific requirements and area desired. When the request has been approved, it is normally the using unit's responsibility to establish the firing line or area and safety limits on the ground. The procedure for conducting these type ranges is the same as for permanent range facilities, subject to any additional restrictions or requirements imposed by the approving authority.

276. Surface Danger Area Diagram

a. Requests for firing in any area for which there is no established range (or when the firing exercise to be conducted will not conform to the limitations of an established range) will be accompanied by a surface danger area diagram (fig. 135). This diagram is made in overlay form and illustrates the firing line or area and safety limits for firing a particular type weapon and ammunition for specific exercises in a given area. It should also include the following information:

(1) Date and time of firing.

(2) Type of weapons and ammunition.

(3) Moving or stationary vehicles.

(4) Moving or stationary targets.

(5) Coordinates of firing points or lines.

(6) Azimuth of right and left firing limits.

(7) Location of safety markers.

(8) Minimum range at which weapons will be fired.

(9) Maximum range at which weapons will be fired.

(10) Range of weapon at maximum prescribed elevation (considering the ammunition to be fired with the greatest range).

Note. The maximum prescribed elevation is normally 15 degrees for direct fire. See AR 385-63 for exceptions and for indirect-fire limits.

(11) Date of preparation.

(12) Preparing agency.

(13) Maps to be included with overlay.

(14) Miscellaneous information as required by local regulations.

b. In the planning and establishing of a tank firing range, the following factors must be considered:

(1) Right and left safety limit markers must be placed to designate the firing limits of each range. Inner safety markers are also set up, as required, to assist in keeping all fire within the designated area. If two inner safety markers are used, tanks right of center on the firing line use the left inner marker and the right outer marker as their safety limits. Tanks left of center use the right inner marker and the left outer marker.

(2) To avoid confusion, red and white poles are used for outer markers and black and yellow poles for inner markers (with a painted design similar to that of barber poles and of sufficient size to be visible to the naked eye from the firing line or position).

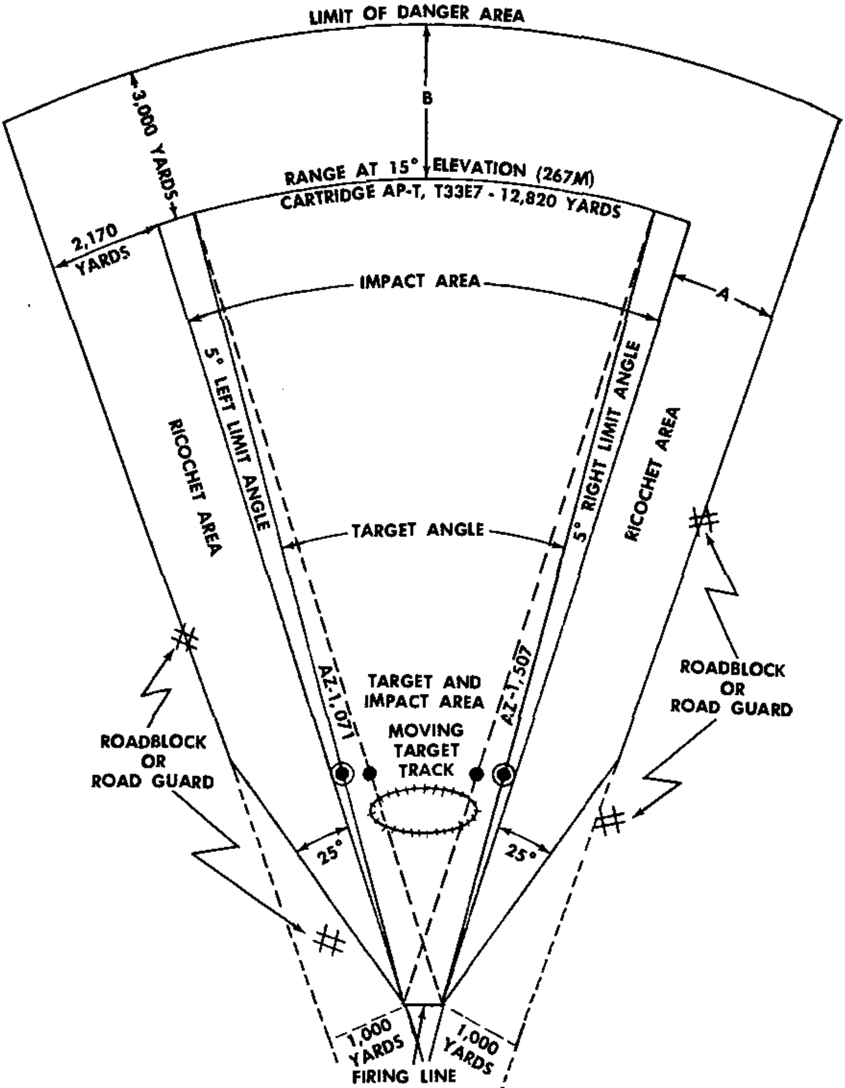
(3) When possible, safety markers (or at least one set) should be placed at the zeroing range for the tank so that they may be used for boresighting and for adjustment of target image coincidence (TIC) or internal correction system (ICS) settings.

(4) When a range is first established, an air space request must be forwarded through channels, to prevent aircraft from flying over the range. This normally is accomplished by post range personnel.

c. See AR 385–63 for information on construction of surface danger area diagrams.

277. Subcaliber Firing Ranges

Subcaliber exercises are fired at a distance of 60 meters. A single range site can be established to facilitate the firing of all subcaliber tables at one location. A target layout for subcaliber firing is shown in figure 136.



①

Surface danger area diagram (overlay).
Figure 135.

278. Service Firing Ranges

Service exercises are fired at distances up to 3,500 meters (yards). To meet the requirements of tank gunnery training, service ranges must be of various types.

a. Stationary target range (fig. 137).

b. Moving target range (fig. 138).

c. Crew field firing range (fig. 139).

d. Crew proficiency range (fig. 140).

OVERLAY: Tank Range No. 5.

MAPS: KENTUCKY, 1:25,000, FORT KNOX, PITTS POINT, COLESBURG, and VINE GROVE.

ORGANIZATION TO FIRE: 1/31 Armor.

DATE AND TIME OF FIRING: 0730 to 1630 hours, 2 June 1960.

TYPE OF WEAPON AND AMMUNITION: Caliber .30 and caliber .50 MG—ball and tracer; 90-mm gun—AP-T and HE-T.

Stationary tanks firing at field targets, stationary panels, and moving targets.

FIRING POINT COORDINATES:

Left end—596101. Right end—597191.

FIRING LIMITS:

Grid azimuth for left firing limit—1,071 mils.

Grid azimuth for right firing limit—1,507 mils.

Inner safety marker (common impact area).

Outer safety marker.

MINIMUM RANGE: 100 yards for MG, and 500 yards for tank gun.

MAXIMUM RANGE OF WEAPON: Range of weapon firing cartridge, AP-T, T33E7, at 15 degrees (267m)—12,800 yards.

MISCELLANEOUS:

Officer in charge of firing is responsible for raising and lowering range flag and manning roadblock as indicated.

PREPARED: 18 May, 1960, S3, 1/31 Armor

Signature B. L. Smith

B. L. SMITH
Major, Armor
S3

②

Surface danger area diagram (text).
Figure 135—Continued

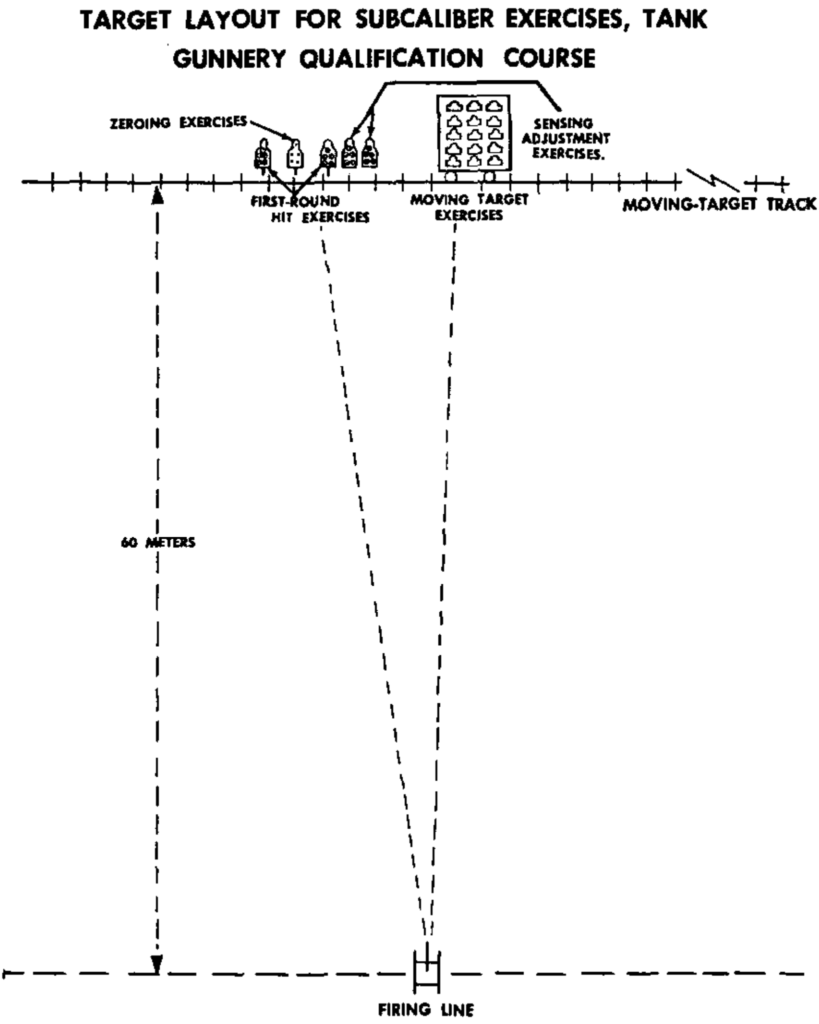


Figure 136. Range setup for subcaliber firing.

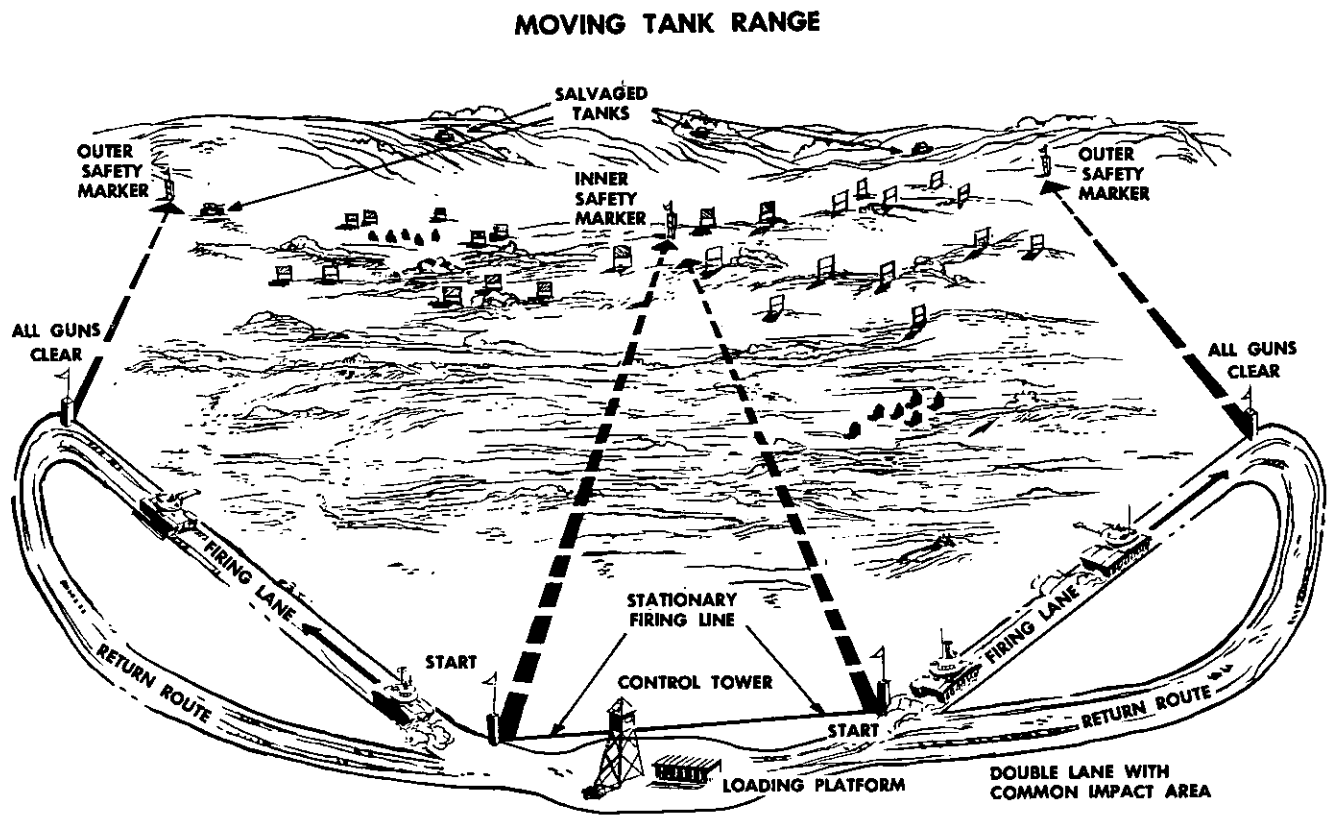


Figure 137. Stationary target range.

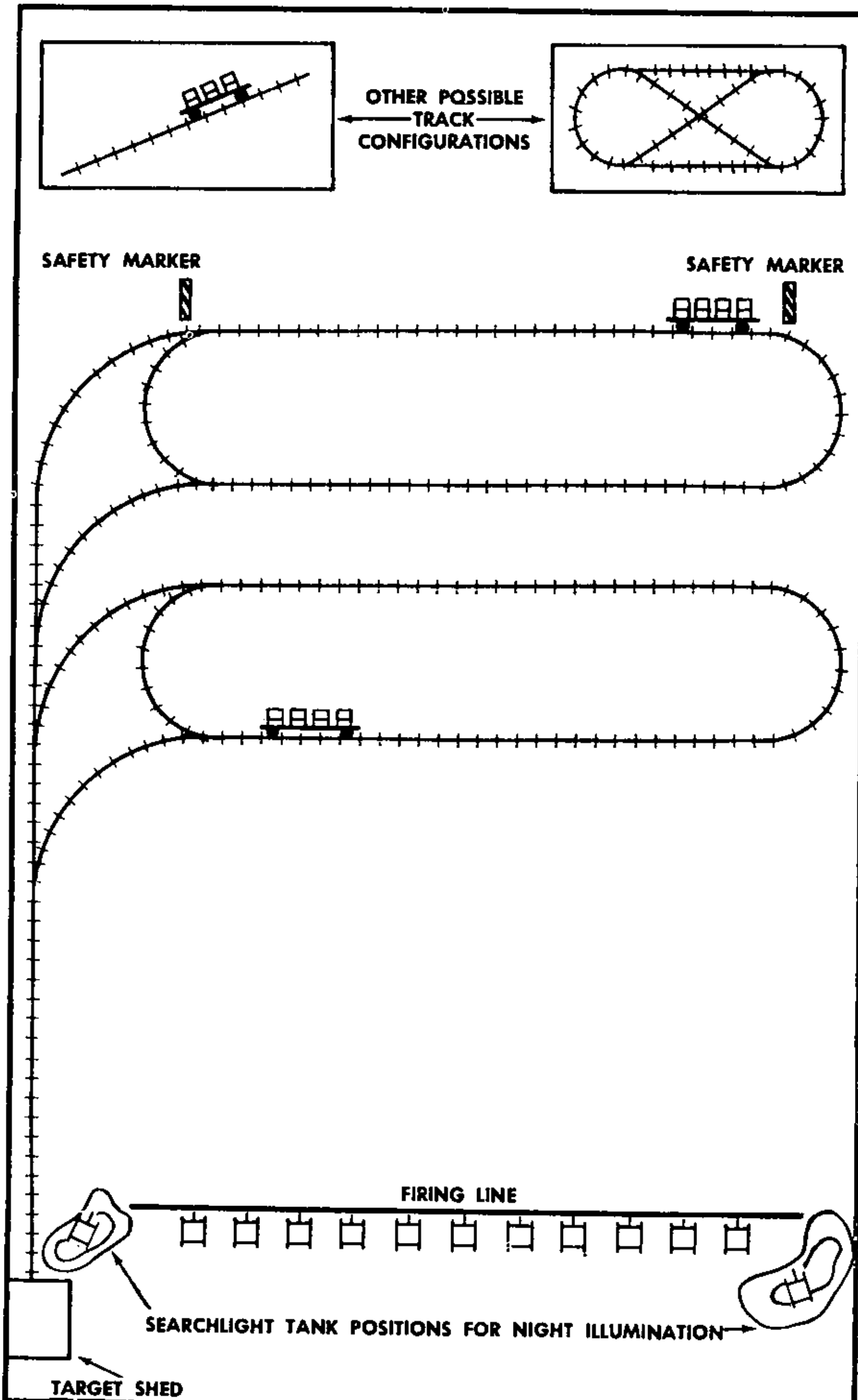


Figure 138. Moving target range.

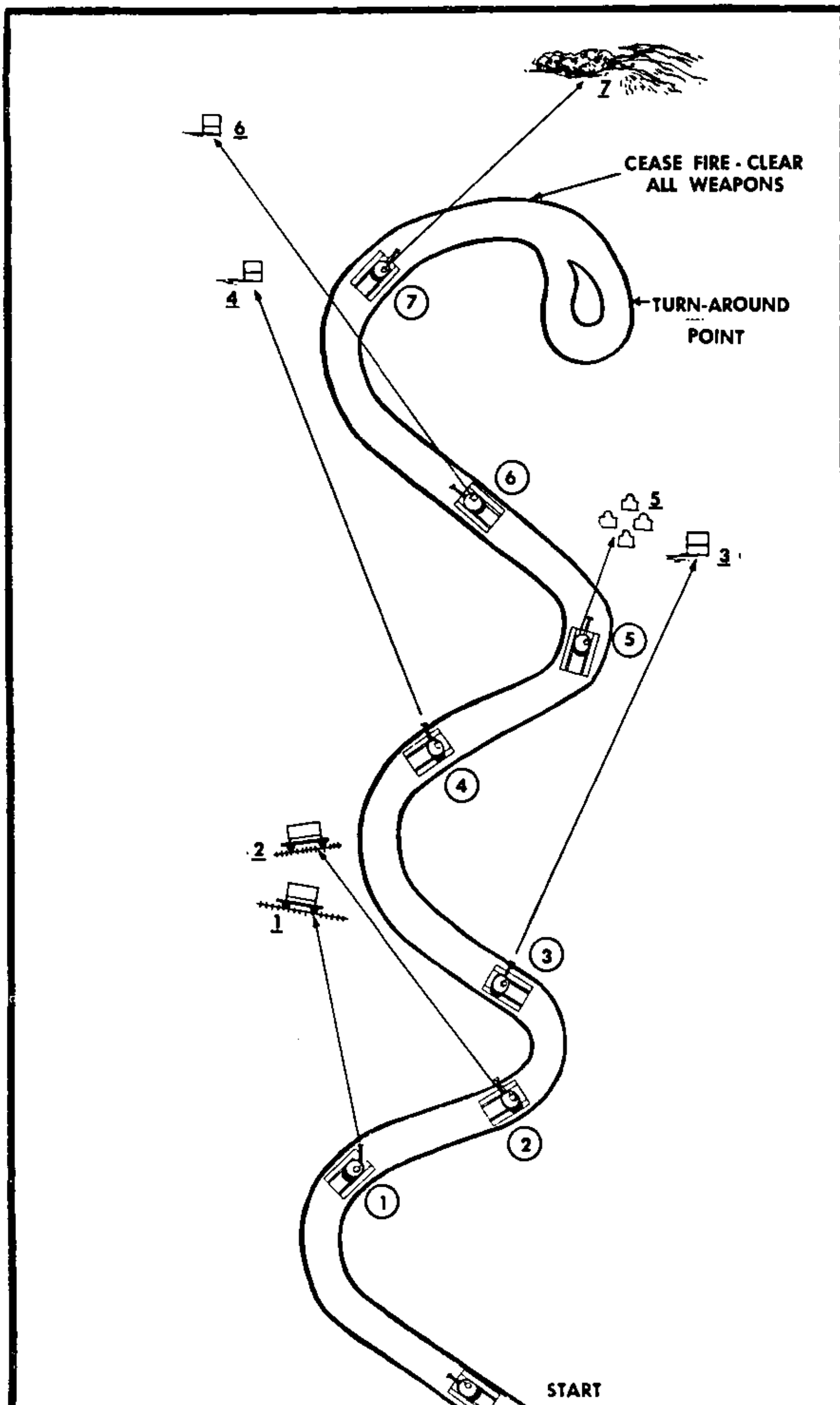


Figure 139. Crew field firing range.

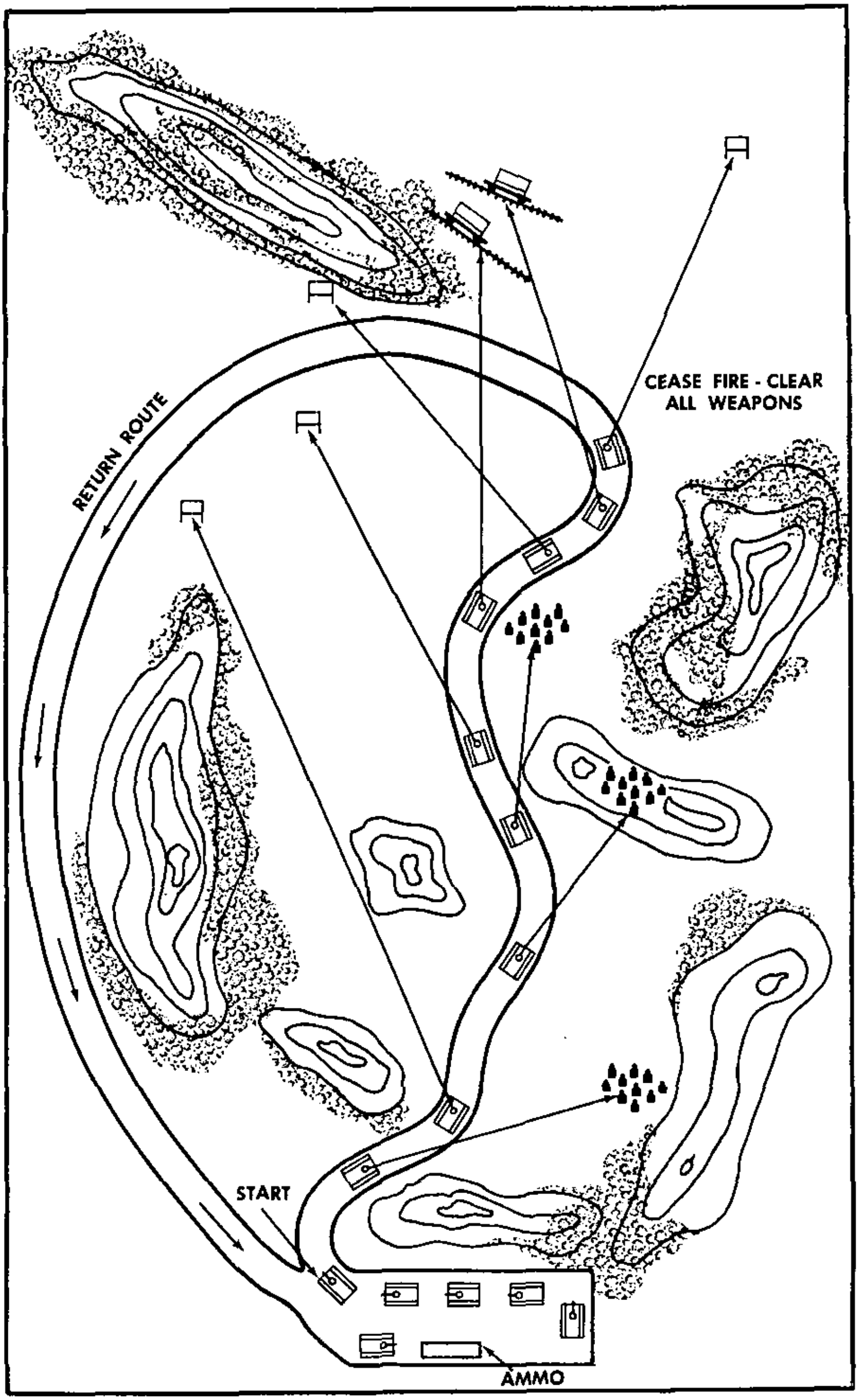


Figure 140. Crew proficiency range.

Section III. CONDUCTING TANK RANGE FIRING

279. General

Thorough planning and supervising are essential to all range firing exercises. The officer in charge of firing is responsible for all activities on the range. He is assisted by a safety officer, who has no duties other than checking and enforcing safety. They must insure compliance with safety precautions prescribed in AR 385–63 and other pertinent directives. To take full advantage of the firing time allotted, all personnel concerned with range firing should become familiar with their duties well in advance of the firing period.

280. Duties of Officer in Charge of Tank Range Firing

The officer in charge (OIC) performs certain duties before, during, and after range firing. The following checklist may be used as a guide in preparing for and conducting range firing:

a. References.

(1) AR 385–63.

(2) Post range regulations.

(3) Unit range SOP.

(4) Current training directives.

(5) Appropriate weapons and ammunition field manuals and technical manuals.

b. Action Prior to Scheduled Day of Firing.

(1) *Analysis of mission.*

(*a*) What is the mission?

(*b*) Who is involved?

(*c*) When is the firing to be conducted?

(*d*) Where is it to be conducted?

(*e*) How is it to be conducted?

(2) *Tentative plan.* Make a tentative plan, to include—

(*a*) Units to fire.

(*b*) Range requirements.

(*c*) Tank requirements.

(*d*) Ammunition requirements.

(*e*) Target requirements.

(*f*) Transportation requirements.

(*g*) Supply (including any special equipment).

(*h*) Concurrent training (when applicable).

(*i*) Assistants required.

(*j*) Mess requirements.

(*k*) Medical support.

(3) *Reconnaissance of range.*

(*a*) Routes and condition of roads.

(*b*) Firing line or area.

(*c*) Target area.

(*d*) Safety limits (check surface danger area diagram).

(*e*) Mess area.

(*f*) Roadblocks and red streamer (and blinking red light for night firing).

(*g*) Communication.

(*h*) Concurrent training area (when applicable).

(*i*) Arrangements for correction of any deficiencies.

(4) *Lesson plan.*

(*a*) Objective of range firing.

(*b*) Standards required.

(*c*) Procedure and exercises to be fired.

(*d*) Plan for movement to and from range.

(*e*) Schedule for firing and concurrent training (when applicable).

(*f*) Equipment and personnel (safety officer, supply and mess personnel, turret mechanics, radio repairmen, tracked vehicle mechanics, aidman, and others as required).

(*g*) Special instructions to participating units.

(*h*) References.

(5) *Preparing range.*

(*a*) Check firing schedule.

(*b*) Check training schedule.

(*c*) Check with local range officer if necessary.

(*d*) Insure that range deficiencies have been corrected.

(*e*) Coordinate with S3.

(*f*) Conduct necessary training of assistants.

(*g*) Check placement of targets.

(*h*) Coordinate with supply, mess, and maintenance personnel.

c. Conduct of Range Firing.

(1) Give final briefing to assistants on the range.

(2) Brief personnel to fire. This briefing is a statement of purpose, objectives, standards, procedures to be followed, and safety precautions to be observed.

(3) Orient and post road guards and check roadblocks.

(4) Check all weapons to be fired to insure they are free of dirt and other obstructions. Check also the weapon record book for the main gun to insure the tube has been

cleared by ordnance personnel (par. 13) to fire sufficient rounds to complete the firing exercises.

(5) Raise red streamer (turn on blinking red light for night firing), visually check the target area to insure that it is clear, and make certain aidman is present with vehicle and first aid kit.

(6) Obtain clearance to fire.

(7) Maintain control of the firing at all times; this control must not be delegated.

(8) Rotate personnel according to plan.

(9) Report and investigate all accidents.

(10) If extension of time is necessary, obtain permission as required.

(11) Report location of duds and misfires, if any.

d. Action After Firing is Completed.

(1) Check all weapons to insure that they are cleared and that all rounds fired by the main gun are properly recorded (par. 13).

(2) Close the range.

(3) Supervise cleaning of weapons.

(4) Turn in unfired ammunition, boxes, and fired cartridge cases.

(5) Police range (including target area if necessary).

(6) Conduct critique.

(7) Insure that personnel have no live ammunition or ammunition components in their possession prior to departure from the range.

(8) Submit necessary reports.

281. Duties of Safety Officer in Tank Range Firing

The safety officer's duty is to prevent any normally safe condition or procedure from deteriorating into an unsafe one; whenever and wherever he sees such a possibility. The safety officer insures that—

a. Safety limits are established on the ground and are understood by all personnel. (Location of safety markers normally is covered by the OIC and tank instructors in their briefings; however, the safety officer should spot check to make certain their location is understood.)

b. All gun tubes are free of dirt or other obstruction before being fired and the weapon record books for the main guns reflect authorization to fire sufficient rounds to complete the firing exercises.

c. Ammunition is handled correctly (par. 285).

d. Personnel mount and dismount from tanks correctly. On ranges that do not require movement of the tank, crews mount and dismount (after assuring that the tank will not be moved) over the right rear or, if the tank has exposed muffiers, over the right center of the tank. On ranges that require movement of the tank, personnel mount and dismount over the right front slope of the tank when weapons are clear.

e. Smoking is not permitted and fires are not built in the vicinity of the tanks or ammunition.

f. The red streamer is displayed at the control point before firing begins (blinking red light turned on for night firing).

g. Range guards are posted, weapons are inspected, and the target area is clear.

h. All range regulations are enforced.

i. No gun is fired unless the range is clear.

j. No gun fires outside the lateral safety limits, above maximum elevation, or below minimum elevation as prescribed by the surface danger area diagram. (In this respect the OIC and safety officer must depend to a large extent on the tank instructors, as it is not always possible to detect a violation before it occurs when viewing the fire from the firing line, control tower, or control vehicle.)

k. No personnel are in the danger area, except as authorized in AR 385-63.

l. He has the following:

(1) Copy of AR 385-63.
(2) Surface danger area diagram of the range area.
(3) Copy of local range regulations.
(4) Binocular.
(5) Red and green signal flags and other forms of communication as directed by the OIC.

282. Communication and Control in Tank Range Firing

a. The post range officer normally controls all ranges by use of wire or radio communication. This control system is for the purpose of obtaining clearance to fire, making reports, coordinating with other ranges, and ceasing fire. The range communication system should allow for immediate shutdown of all ranges in the event of an emergency.

b. The range OIC controls firing by use of signal flags, radio, telephone, and public address systems. Signal flags are displayed at the control point and on tanks during range firing; other control measures are used only as required to maintain positive control of the firing or as required by local range regulations or unit SOP's.

c. Within the tank, control is exercised by use of the tank interphone system.

d. The flag displayed at the control point indicates whether firing may be conducted. A red flag means firing may be conducted; a green flag means firing may not be conducted.

e. The flags displayed on a firing tank indicate the following:

(1) *Red flag.* Tank is carrying live ammunition and engaged in firing. The weapons must be pointed at the target area.

(2) *Green flag.* All tank weapons are clear and elevated. Any live ammunition in the tank is properly stowed.

(3) *Orange flag.* Tank has a malfunction; used only in conjunction with other flags in tank gunnery (red and green).

(4) *Red and green flags.* Tank crew is preparing for firing or performing a nonfiring exercise; all weapons are clear, but not elevated.

(5) *Red and orange flags.* Tank has a malfunction or misfire; weapons are not clear and are pointed at the target area.

(6) *Green and orange flags.* Tank has a malfunction; all weapons are clear.

283. Safety Precautions in Tank Range Firing

The officer in charge of firing is responsible for all safety measures. He is assisted by a safety officer, who will have no duties other than those concerned with safety, and by the tank instructors.

a. No gun will be loaded (or half-loaded) until a command to do so has been given.

b. Before machinegun firing, the safety officer will ascertain that all bolts are open and a cleaning rod and dry patch have been run through and removed from the muzzle end of each gun bore.

c. The OIC will make certain that there are no trees or other obstructions in the line of fire that might cause an explosion of an HE or HEP round at close range.

d. In training, the main gun is depressed to the maximum before firing the caliber .50 machinegun.

e. In emergencies, anyone may give the command CEASE FIRING. Firing will cease immediately, regardless of the source of the command.

f. Whenever there is a cessation of fire, breechblocks will be opened and machineguns unloaded and bolts held to the rear (by locking or with T-blocks).

***Caution.* If for some reason a round has been in a hot weapon long enough to produce a cookoff (approximately 3 minutes for the main gun and 10 seconds for a machinegun) when a cease fire is given, the tank instructor will not allow it to be removed. Instead, he will notify the OIC of the situation and request permission to fire to clear the weapon. If firing of the weapon is inadvisable, it will be kept pointed at the target area. If the main gun is involved, the crew will evacuate the tank until the weapon is cool.**

g. After machineguns are fired, before being dismounted or removed from the tank, each gun will be inspected to see that it is unloaded.

h. Tank weapons must always be elevated after firing so that any accidental discharge of the guns resulting from failure to clear guns will go above personnel moving about in front of the tank. This procedure, however, does not eliminate the necessity for clearing the guns.

284. Duties and Safety Precautions Checklist for Tank Instructors

The duties of the tank instructors are to instruct, supervise, and insure compliance with the following:

a. General.

(1) No smoking near ammunition or tanks.

(2) No standing on top of the turret.

(3) Personnel mount stationary tanks on a firing line from the right rear (or right center on tanks with exposed mufflers).

(4) Driver must be alert when personnel are mounting the tank on moving tank ranges; they mount over the right front slope of the tank.

(5) All personnel must keep clear of the path of recoil and keep their bodies entirely inside the turret ring.

(6) Misfires are reported to the OIC.

b. Tank Commander's Position.

(1) Keep finger off firing trigger unless firing.

(2) Be prepared to override gunner with power controls if

he is committing an unsafe act (on tanks with a tank commander's override).

c. *Gunner's Position.*

(1) Keep fingers off the firing triggers until ready to fire.

(2) Do not fire unless target is clearly identified.

(3) Do not fire until after hearing the loader announce UP.

(4) Announce ON THE WAY and pause one second before firing.

(5) In case of a misfire or stoppage, turn off firing switch and announce MISFIRE (STOPPAGE) and perform appropriate drill.

d. *Loader's Position.*

(1) Insure that ammunition is properly stowed and secured and that the primer is protected at all times.

(2) Use asbestos gloves to handle hot brass.

(3) Do not throw empty brass out unless area alongside of tank is clear.

(4) Use the extracting and ramming tool to close the breech when a round is not being loaded, to remove a stuck round, and to chamber a round that has failed to chamber during loading of the weapon.

285. Arrangement and Handling of Ammunition and Containers for Tank Firing

a. Ammunition, boxes, and expended cartridge cases for stationary tank firing are stacked as shown in figure 141 and for moving tank ranges as shown in figure 142.

b. Ammunition is laid on a tarp, fuze toward muzzle of tank gun, and stacked no more than two layers high. On stationary tank ranges, the front edge (toward muzzle) of the tarpaulin is kept free so it can be folded back over the ammunition and the gun's muzzle blast will not uncover the ammunition.

c. The proper method of unpacking and handling ammunition is to remove containers from boxes, place cap end of container on the ground, and remove tape. Pull up on large portion of container and remove from round, holding the round steady with the other hand. Place one hand around projectile, pick the round up (after upending it—primer end up), flip off the cap, and place hand over the primer. The round is then carried in this manner to the tarpaulin or the tank.

286. Targets for Tank Gunnery Ranges

a. *General.* There are two general categories of targets for tank

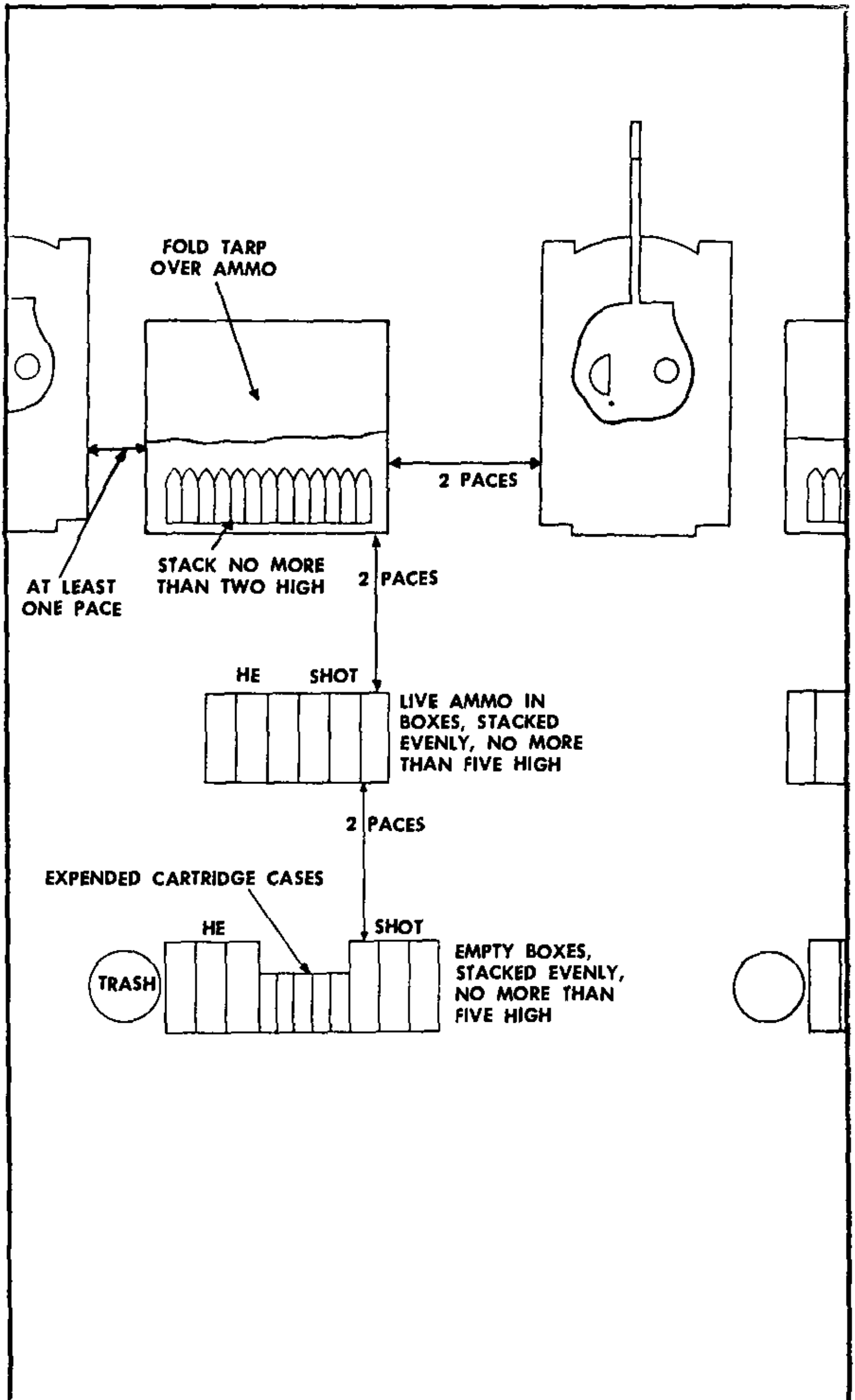
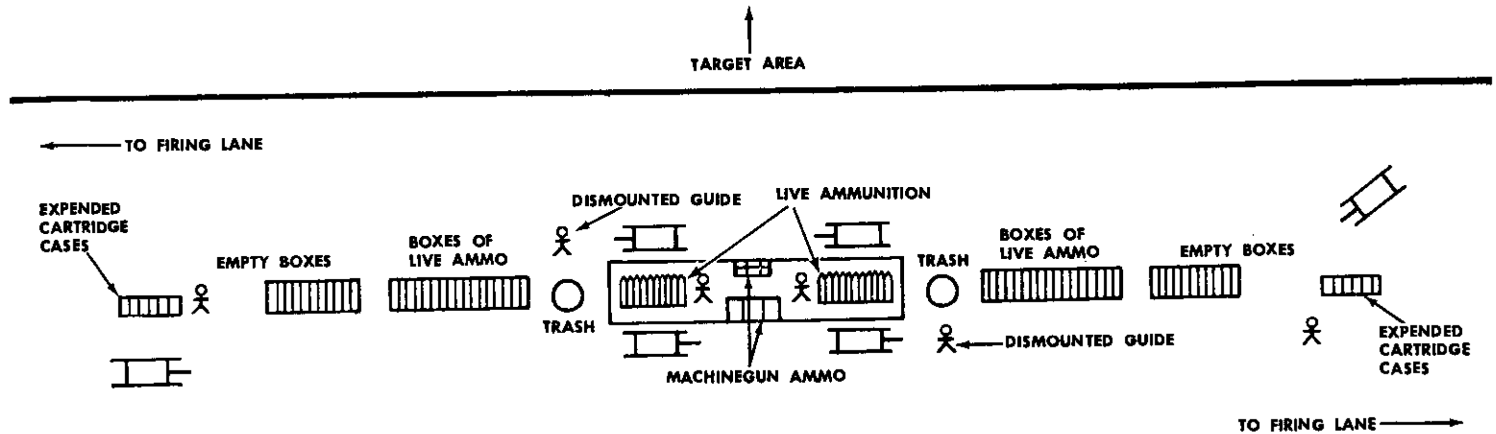
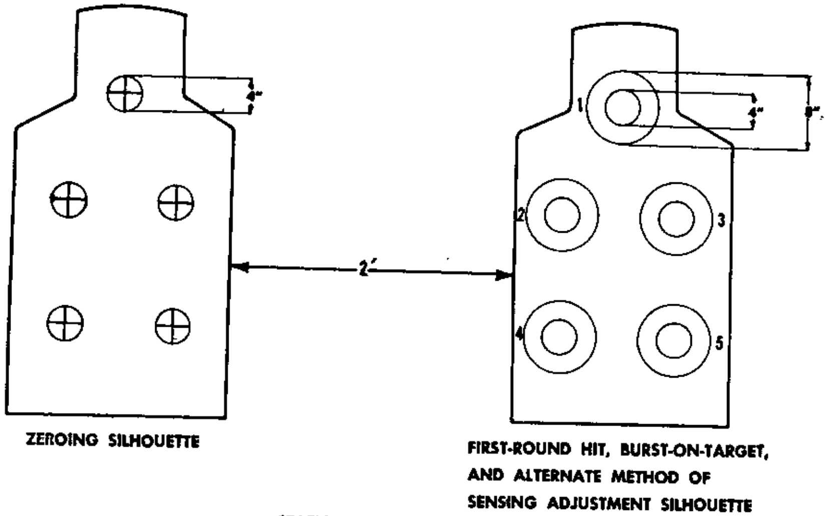


Figure 141. Arrangement of ammunition and containers for stationary firing.



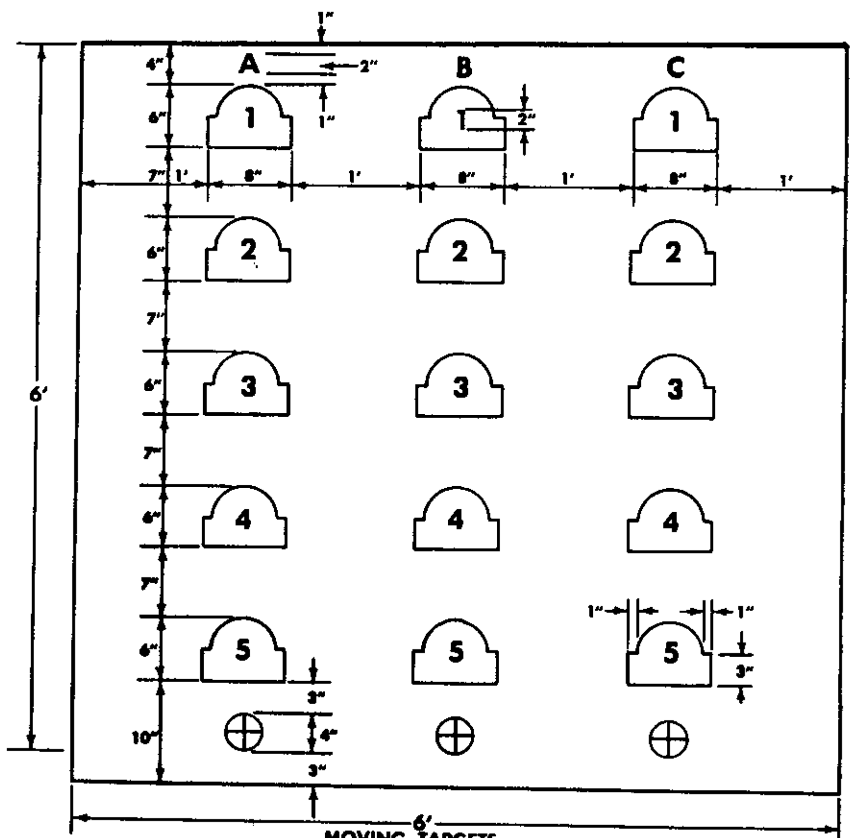
Notes:
(1) Stack all main gun ammunition boxes evenly, no more than five high.
(2) Stack live ammunition on ramp no more than two high.
(3) Stress safety around the loading ramp. Use dismounted guides to bring tanks up to the loading ramp.
(4) After completing a firing run, have the expended cartridge cases for the main gun removed from the tank and placed in the designated area.
(5) Do not load the tank with ammunition after each firing run if a sufficient amount is loaded to complete more than one firing run.

Figure 142. Arrangement of ammunition and containers on moving tank ranges.



STATIONARY TARGETS

Figure 143. Targets for subcaliber firing.



MOVING TARGETS

Figure 143—Continued.

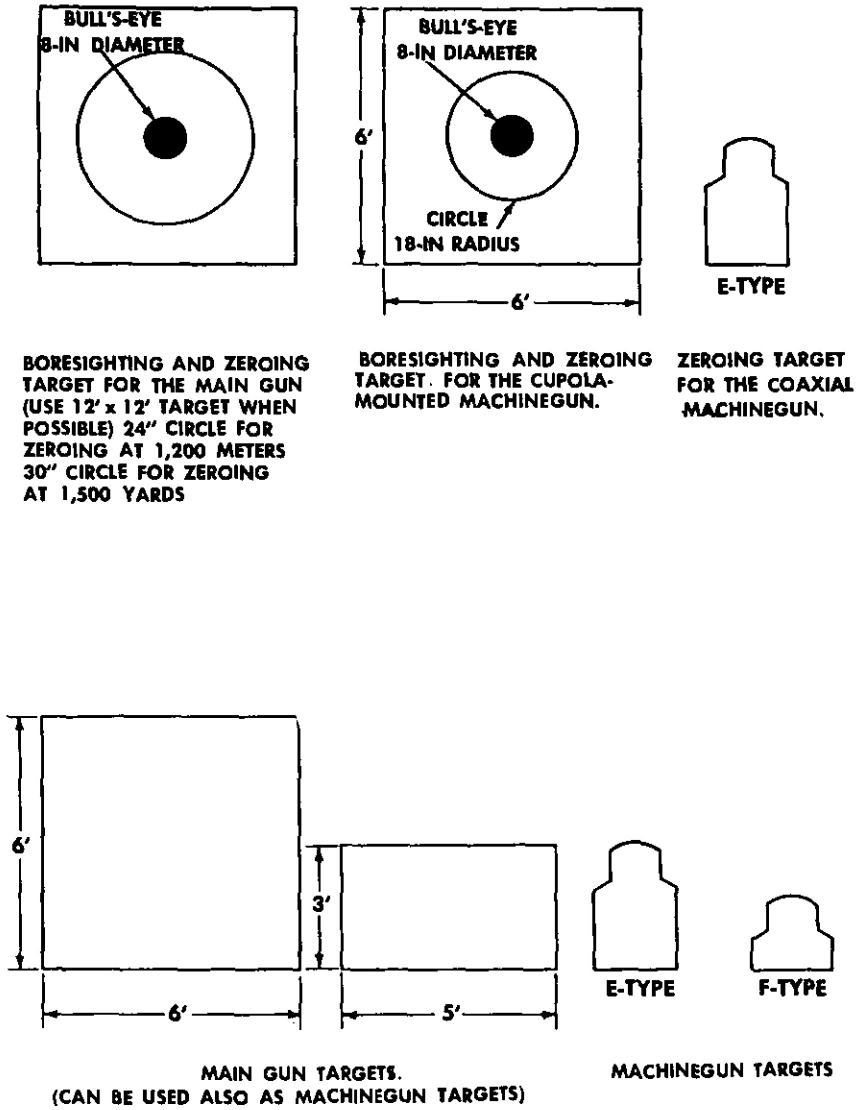


Figure 144. Targets for service firing.

gunnery ranges: those for subcaliber firing and those for service firing.

b. Subcaliber Firing Targets (fig. 143).

c. Service Firing Targets (fig. 144). For qualification firing, the size of the targets must conform to the dimensions outlined in each table. To add realism during service firing, tank hulls or other salvaged vehicles should be used as targets, target panels may be constructed to look like some type of combat vehicle, or vehicle silhouettes may be painted on panel targets; but the scoring of hits on such targets must be limited to an area of a size specified in the qualification tables. When panel targets without markings are used in training, they should be designated a specific type of combat target by the instructor or examiner, when appropriate, so that the tank commander will be required to make a decision as to the type of ammunition to use. In addition to cloth, panel targets may be constructed of metal, plywood, or some type of artificial material. Any of these items increase the permanency of the target and, when using some type of metal, hits can be more easily sensed. Olive drab cloth instead of white cloth may be used to increase the difficulty of locating targets. When targets are placed close to each other, a number, letter, or color code (or combination of these) may be painted on the targets to facilitate target location.

APPENDIX
REFERENCES

1. Field Manuals

FM 6–40	Field Artillery Cannon Gunnery.
FM 6–135	Adjustment of Artillery Fire by the Combat Soldier.
FM 17–1	Armor Operations, Small Units.
FM 17–35	Tank Units, Platoon, Company, and Battalion.
FM 17–33	Armored Cavalry, Platoon, Troop and Squadron.
FM 17–79	Tank, 90-mm Gun, M48.
FM 17–80	Tanks, 76-mm, M41 and M41A1.
FM 20–60	Battlefield Illumination.
FM 21–5	Military Training.
FM 21–6	Techniques of Military Instruction.
FM 21–30	Military Symbols.
FM 23–55	Browning Machineguns, Caliber .30.
FM 23–65	Browning Machineguns, Caliber .50.

2. Technical Manuals

TM 5–6230–201–15	Operator's Organizational, Field, and Depot Maintenance: Searchlight, 18-Inch.
TM 9–525	Graphical Firing Tables.
TM 9–575	Auxiliary Sighting and Fire Control Equipment.
TM 9–1300–203	Ammunition for Antiaircraft, Tank, Antitank, and Field Artillery Weapons.
TM 9–1900	Ammunition, General.
TM 9–1901	Artillery Ammunition.
TM 9–1903	Care, Handling, Preservation, and Destruction of Ammunition.
TM 9–1907	Ballistic Data Performance of Ammunition.
TM 9–1990	Small Arms Ammunition.
TM 9–2350–201–12	Operation and Organizational Maintenance, 76-mm Gun, Full-Tracked Combat Tanks, M41 (TF41E1) and M41A1 (T41E2).
TM 9–2350–215–10	Operation and Organizational Maintenance, 105-mm Gun, Full-Tracked Combat Tank, M60.

TM 9–2601	Elementary Optics and Application to Fire Control Instruments.
TM 9–3305–1	Principles of Artillery: Weapons.
TM 9–3305–2	Principles of Fire Control Materiel.
TM 9–6166	Operation and Organizational Maintenance, Aiming Circle, M2.
TM 9–7012	90-mm Gun, Full-Tracked Combat Tanks, M48, M48A1, and M48C.
TM 9–7022	Operation and Organizational Maintenance, 90-mm Gun, Full-Tracked Combat Tank, M28A2.
TM 11–284	Radio Sets; AN/GRC–3, –4, –5, –6, –7, –8.

3. Regulations

AR 320–5	Dictionary of United States Army Terms.
AR 320–50	Authorized Abbreviations and Brevity Codes.
AR 370–5	Qualification in Arms (Qualification and Familiarization).
AR 385–63	Safety (Regulations for Firing Ammunition for Training, Target Practice, and Combat).
AR 600–70	Personnel Badges.

4. DA Pamphlets

DA Pam 108–1, Index of Army Motion Pictures, Film Strips, Slides and Phono-Recordings.

DA Pam, 310-series, Military Publications (Indexes).

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NG: State AG (3); units—same as Active Army except allowance is two (2) copies to each unit.

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For explanation of abbreviations used, see AR 320–50.

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